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Insects and Diseases of Alaskan Forests

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Preface

The USDA Forest Service publication, "Identification of Destructive Alaska Forest Insects" (Hard 1967), dealt main with the more damaging forest insects of southeastern Alaska. Since then, our information on forest insects and diseases from south-central and interior Alaska has increased. Some of these insects and diseases are now damaging or potentially hazardous to the environment, enough so to be included with the previous list.

Although southeast Alaska forest pests remain serious, more emphasis has been given to south-central and interio Alaska forest pests as interest in forest management is ris ing in these areas. But, not every insect or disease in Alas is covered in this report. Some are omitted because of limited distribution or minor importance, and others are awaiting more comprehensive surveys and information on their economic importance.

This handbook is divided into insect and disease sections. Each has its own keys, illustrations, literature cited, glossary, and host index.

Contents

The handboook is divided into two sections: Insects and Diseases. Each section contains a list of selected references, a glossary of terms, and a host index. Following the two sections is an Appendix which includes instructions for pest identification, and a list of credits.

Introduction

The sciences of forest entomology and pathology or the study of forest insects and disease are relatively new to Alaska. Even though insect and disease surveys have been undertaken for over 40 years, many pests have only recently been identified. Alaska's forests are becoming economically important in terms of wood production, wildlife habitat, and recreation. Forest resource management cannot be practical in Alaska until forests are adequately protected from insect, disease, and fire losses. Forest managers should be able to determine which pests are detrimental to the multiple-use concept of forest resource management. Likewise, private land managers and homeowners should learn to identify pests that invade and attack their trees and shrubs.

We must not underestimate the effects of forest pests whose damage can occur during every stage of forest growth. Nationally, insects kill twice as much timber as do disease-causing organisms, and seven times the amount killed by fire. But, on an annual basis, the loss of potential growth and decay caused by disease exceeds the more spectacular damage caused by fire and insects. Forest insects and disease were responsible for damage on approximately 2.67 million hectares of forest land in the United States in 1974 (59). One group of forest pests, the bark beetles, is responsible for annual losses of millions of cubic meters of sawtimber (27). 2.471 acres equal one hectare; 5 board feet equal one cubic foot; and 35.32 cubic feet equal one cubic meter.

Some documented insect outbreaks in Alaska include 200,000 hectares of white spruce killed by the spruce beetle in the Copper River drainage in 1959, 6.4 million hectares of Sitka spruce-western hemlock forests of southeast Alaska defoliated by larvae of the black-headed budworm in 1953, 1.6 million hectares of western hemlock in southeast Alaska defoliated by hemlock sawfly larvae in 1955, and 2.3 million hectares in 1958, and one million hectares in 1975 defoliated by larvae of the spear-marked black moth in interior Alaska. Other smaller outbreaks occur annually throughout the forested areas of the State. The annual volume and monetary loss attributed to insects and diseases are unknown in Alaska.

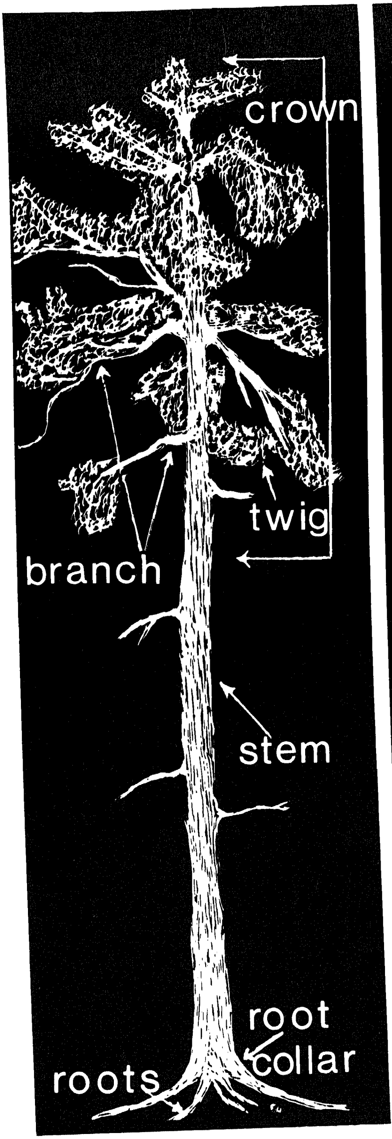

Figure 1—Parts of trees commonly affected by forest pests.

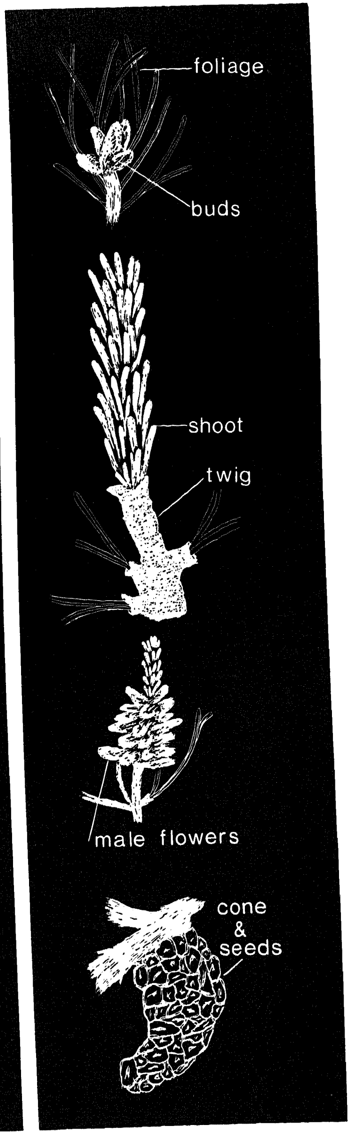

Figure 2—Specific parts of a tree affected by forest pests.

A short identification or classification key follows this introduction and directs the reader to the appropriate insect or disease chapter. Within most chapters, another key will direct the reader to the insect or disease in question. When using the keys, start with the first couplet and decide which alternative best fits the situation at hand. Then, refer to the number following that alternative, and continue until the insect or disease has been identified. For each species a summary of its hosts, damage, distribution, and biology is provided. References for each pest are also listed.

Few chemical suppression measures are included for the pests covered in this manual because many new control measures are quickly outdated or discarded because of new advances, environmental hazards, or lack of benefit/cost effectiveness. Please refer to the nearest office of State and Private Forestry (USDA Forest Service) or the Alaska State Forester for information concerning specific control measures.

Identification Key to Major Groups of Forest Insects and Diseases of Alaska

1. Damage occurs to wood exposed in salt or brackish water ______ **Marine Borers.**

1'. Damage done to host on land ______ 2

2. Host is a hardwood ______ 3

2'. Host is a conifer ______ 6

3. Damage to wood products in use **Powder Post Beetles.**

3'. Damage to living trees, dead trees, logs ______ 4

4. Damage primarily on leaves ______ 5

4'. Damage to other parts of tree ______ 7

5. Leaves chewed, mined, skeletonized or webbed. From a distance affected trees have a brownish cast. Insects associated with the damage are either caterpillar-like or beetle-like ______ **Defoliators.**

5'. Enlarged growth (galls) or foliage disturbances, such as bleaching, yellowing or curling ______ 8

6. Damage to wood structures or wood products in use ______ **Wood Products Insects.**

6'. Damage to living, weakened or dead trees and logs ______ 9

7. Larval galleries and borings into the sapwood and at times, the heartwood of weakened, recently felled or dead hardwoods, boring dust coarse ____ **Wood Borers.**

7'. Mushrooms or conks present on or near the stem. Heartwood and sapwood may be discolored and/or rotted. Roots sometimes affected leading to a rapid decline in host vigor. Primarily in older trees ______ **Decays.**

8. Honeydew many times present, curled or discolored foliage, **insects or their cast skins present** ________ **Sapsuckers.**

8'. Little or no honeydew, curled and discolored foliage, trunk deformities and cankers sometimes present. **Insects absent** or if present, usually not associated with site of injury ________ **Hardwood Diseases.**

9. Damage confined to needles, buds or shoots ________ 10

9'. Damage to other parts of the tree ________ 15

10. Affected needles with a reddish cast, insects or signs of their feeding present ________ 11

10'. Affected needles orange or brown in color or no color change at all. Small fruiting bodies may be present on affected foliage ________ 12

11. Damaged needles, whole insects or their cast skins small (1-2 mm long)*; cottony tufts, galls, and honeydew sometimes present ________ **Sapsuckers.**

11'. Needles and buds are partially or totally consumed; no honeydew. Caterpillar-like insects usually present on foliage in early spring or summer. ________ **Defoliators.**

12. Small colored fruiting bodies on new year's growth ________ 13

12'. Abnormal growth or distinct dieback of new growth ________ 14

13. Small dark brown fruiting bodies on upperside of needles. Affects all ages of cedar ________ **Cedar Leaf Blight.**

13'. Small orange fruiting bodies covering current year's growth on white, black, and Sitka spruce ________ **Spruce Needle Rust.**

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*/ 10 millimeters = *1 centimeter; 1 centimeter* = 0.40 inch.

14. Wilting and dieback of new shoots, little or no discoloration, on western hemlock and rarely Sitka spruce ________ **Sirococcus Shoot Blight.**

14'. Perennial greenish to grey witches broom on white, black and Sitka spruce ________ **Spruce Broom Rust.**

15. Damage confined primarily to cones and seeds ________ **Seed and Cone Insects.**

15'. Damage confined to stems, roots and limbs of conifers ________ 16

16. Insect activity characterized by boring dust and resin on bark and around base of trees. Galleries commonly found under bark and at times into the sapwood and heartwood ________ 17

16'. Galls, stem deformities, sapwood and heartwood rot may be present. Insect activity usually absent ________ 18

17. Larval galleries up to 0.6 cm in diameter. Larval borings usually granular. Galleries penetrate into the sapwood and at times the heartwood of weakened or recently killed trees or logs ________ **Wood Borers**

17'. Boring dust reddish to light brown and fine. Galleries usually less than 0.6 cm in width; common under the bark scouring the sapwood, rarely penetrating the wood ________ **Bark Beetles.**

18. Mushrooms or conks present on or near the stem; many times the heartwood and sapwood is discolored, rotted and crumbly; roots may be affected; older trees primarily affected ________ **Decays.**

18'. Stem and branch deformities, cankers, and galls may be present ________ 19

19. Roundish galls on the branches and small stems of Lodgepole Pine. Galls may eventually girdle and kill the branch or stem ____________________ **Western Gall Rust.**

19'. Large witches brooms and cankers may be present on the limbs; burls and cankers sometimes on the stem; primarily on western hemlock, rarely on Sitka spruce ____________________ **Dwarf Mistletoe.**

Forest Defoliators

Defoliators eat the leaves or needles of forest trees. Defoliators are, at times, a very destructive insect group. An estimated 15 percent of insect-related forest growth impact in the United States is caused by defoliators (46). Unlike the bark beetles, defoliators usually do not kill trees but slow down tree growth and increase susceptibility to other insects and diseases. These types of damage are collectively referred to as growth impact.

The effects of defoliation, however, can be viewed positively. The opening of the forest canopy allows greater light penetration to the ground level. This increased light results in new seedlings and increased ground cover of herbaceous plants and more rapid soil nutrient recycling. These changes can result in **greater** forest and browse production through increased plant growth.

All species of trees are not equally susceptible to injury from defoliation (32). Hardwood species are relatively resistant. These species can usually withstand several years of defoliation with little tree mortality because hardwoods store large food supplies and can refoliate in the same year. On the other hand, conifers are more easily killed; one complete defoliation at the right time of year can cause tree mortality.

The timing of defoliation is important relative to its effect on tree health (32). For example, if complete defoliation of a conifer occurs before midsummer, the trees will not have formed buds for the following year. Then a single 100 percent defoliation can kill the trees.

In this text, defoliators are grouped by their feeding habits. Accordingly, defoliators are:

- **Leaf Chewers** which eat all the leaf tissues (succulent tissues, veins, midrib). They are the most damaging defoliators.

- **Leaf Miners** which feed upon the succulent tissues while tunneling between the upper and the lower epidermal layers of the leaf.

- **Skeletonizers** which eat all the leaf tissue except for the veins and midrib.

The most important tree-defoliating pests are sawflies (Hymenoptera), leaf beetles (Coleoptera) and the caterpillars (Lepidoptera).

Identification Key

1. Conifers ______ 2

1'. Hardwoods ______ 8

2. New foliage of opening buds chewed and tied together to form a shelter, larvae wiggle violently backwards or fall to the ground when disturbed 3

2'. New and old foliage affected; needles not tied together; hanging silk webs sometimes present 5

3. Yellowish to grayish green larvae with brownish yellow heads; new needles of opening buds damaged; on young Sitka spruce or larch ______ Bud Moths
Zeiraphera spp.

3'. Larvae either dark brown or bright green with black heads ______ 4

4. Damage usually confined to western hemlock in southeast Alaska, will occasionally attack spruce ______ Black-headed Budworm
Acleris gloverana

4'. Damage usually confined to Sitka or white spruce throughout Alaska ______ Spruce Budworm
Choristoneura spp.

5. Old foliage entirely chewed; needle stubs or midribs remaining; caterpillar frequently holding one end of body in midair when disturbed; feeding in groups on western hemlock ______ Hemlock Sawfly
Neodiprion tsugae

5'. New and old foliage consumed on one side or with bites removed; needles sometimes present on host; larvae crawling with a looping motion ______ 6

6. New and old needles and sometimes small twigs chewed off at their base or needles eaten on one side or with bites removed; hanging silk webs present on host; mature larvae brownish grey with two pairs of dark spots on each body segment; hosts include western hemlock, Sitka spruce, western red cedar, and Alaska yellow cedar ______ Western Hemlock Looper
Lambdina fiscellaria lugubrosa

6'. Defoliation not as above; larvae not brownish grey ______ 7

7. Late instars deep apple-green with white and yellow-green lateral stripes, head pale green; terminal and subterminal sections of needles chewed; feeding usually heaviest on previous years foliage in upper crowns; on western hemlock, western red cedar, Alaska yellow-cedar ______ Greenstriped Forest Looper
Melanolophia imitata

7'. Late instars with a distinctive inverted "V" on the second abdominal segment but indistinct or missing in mature larvae; mature larvae brownish with reddish diamond-shaped marks on back; defoliation of host associated with heavy defoliation of deciduous understory; on western hemlock, but other conifers and deciduous trees and shrubs infested ______ Saddleback Looper
Ectropis crepuscularia

8. Leaves rolled or tied together to form a shelter; feeding within ______ 9

8'. Leaves chewed or mined or skeletonized or stripped from trees ______ 10

9. Mature larvae are about 1.6 mm long, having black bodies with a whitish pink spot on the side of each body segment; dark brown heads; edges of one to several leaves tied together to form tent-like structures; on birch. ________ Spear-Marked Black Moth
Rheumaptera hastata

9'. Mature larvae grey-green to black with dark head capsules; leaves are rolled and tied together; feeding mainly confined to aspen ________ Large Aspen Tortrix
Choristoneura conflictana
and other leaf rollers

10. Leaves entirely or partially chewed ________ 11

10'. Leaves distinctly mined or skeletonized ________ 12

11. Leaves of various deciduous trees and shrubs chewed; larvae crawling with a looping motion; larvae indistinguishable from small twigs; on Kodiak Island ________ Kodiak Looper
Operophtera hyperboreata

11'. Alder leaves chewed except for midribs and major veins ________ Striped Alder Sawfly
Hemichroa crocea

12. Poplar, aspen, birch, alder, and willow leaves skeletonized; larvae flattened dark grubs with well-developed legs; adults oval, yellowish with black markings ________ Leaf Beetles
Chrysomela spp.

12'. Aspen and poplar leaves with conspicuous serpentine mining; larvae approximately 5 mm long located within mines ________ Leaf Blotch Miner
Phyllocinistis populiella
Lithocolletis ontario

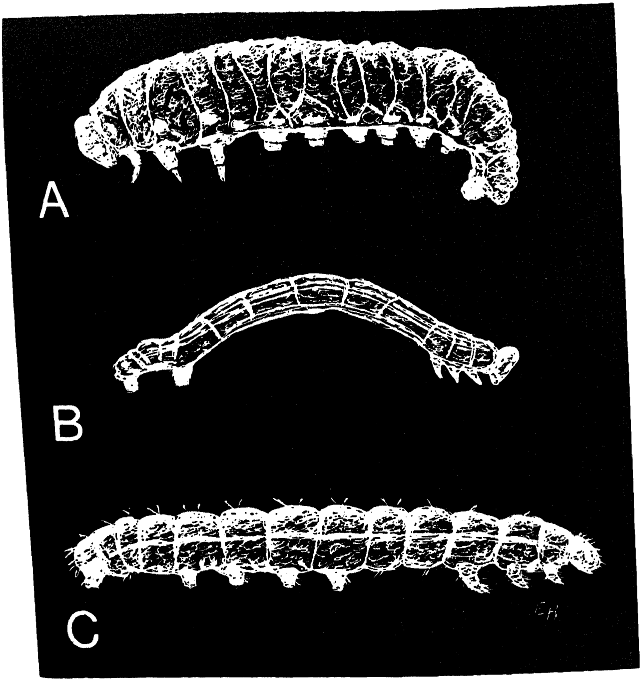


Figure 3—Defoliators: A. Sawfly larva (Hymenoptera); B. Looper (Lepidoptera: Geometridae); C. Budworm (Lepidoptera: Tortricidae).

BLACK-HEADED BUDWORM
LEPIDOPTERA: TORTRICIDAE
Acleris gloverana (Wals.)

HOST—Western hemlock (preferred host), Sitka and white spruce.

DAMAGE—The black-headed budworm is one of the most destructive forest insects in coastal southeast Alaska. During the 1950's, almost one-third of the net volume was lost on some southeast Alaska hemlock sites due to budworm defoliation. Localized outbreaks have occurred sporadically since then. Larval feeding strips host foliage and can bring about a reduction in growth, top kill, and at times, tree mortality.

DISTRIBUTION—Primarily in southeast Alaska, but occasionally in forests of Prince William Sound.

DESCRIPTION—Adults are small brownish grey moths with variable brown, black, orange, and white markings. The larval head is black during the first four larval stages and tan-orange in the last stage. Mature larvae are 1.7 cm long.

BIOLOGY—Black-headed budworms overwinter in the egg stage on host foliage. The eggs hatch in June and feeding begins. Budworm and hemlock life cycles are closely synchronized; young larvae feed within the protection of unopened hemlock buds. As the shoots begin to elongate the larvae feed on the new needles. Larvae usually confine their feeding to new growth. In large concentrations, the larger larvae will feed on older needles, thus bringing about complete defoliation.

Each mature larva ties live and cut needles together and pupates within this shelter. Adults emerge in late August through October. Mated females lay flat, yellow eggs singly on the underside of host needles; mean fecundity of a population is 87 eggs per female.

Populations of this species are characterized by sporadic spectacular increases in number followed two-to-three years later by equally rapid declines. Only 16 species of parasites and predators have been identified in Alaska compared to 48 species in coastal British Columbia. Adverse weather may be an important controlling factor for southeast Alaska budworm populations.

To date, no suppression actions have been taken as budworm populations disappear as rapidly as they appear. However, the budworm is a definite threat to young stands.

REFERENCES—1, 5, 27, 34, 36, 44, 53, 54, 61, 67.

SPRUCE BUDWORM
LEPIDOPTERA: TORTRICIDAE
Choristoneura spp.

HOST—Sitka and white spruce.

DAMAGE—Larvae destroy buds, host foliage, cones and seeds.

DISTRIBUTION—Uncommon in Alaska. Populations have been found as far north as Fairbanks.

DESCRIPTION—Adults are predominantly grey-brown and have a wingspread of 22 to 28 mm. Eggs are light green and are laid in shinglelike masses on the underside of needles. Mature larvae are approximately 32 mm long, with brownish head and body and prominent ivory-colored spots.

BIOLOGY—Similar to *A. gloverana* in biology. However, the spruce budworm overwinters as larvae in silken shelters beneath bark scales and old male flowers. Larvae enter and feed upon buds in May or June, then attack new foliage.

REFERENCES—27, 35.

LARGE ASPEN TORTRIX
LEPIDOPTERA: TORTRICIDAE
Choristoneura conflictana (Wlk.)

HOST—Aspen.

DAMAGE—Larvae skeletonize both upper and lower leaf surfaces.

DISTRIBUTION—Principally in interior Alaska. This insect was first recorded from Alaska in 1966 when it reached outbreak conditions on more than 2,023 hectares of aspen near Fairbanks.

DESCRIPTION—Larvae are grey-green to black with dark head capsules. Adult moths are grey. The forewings are grey with brownish markings. Green eggs are deposited in masses.

BIOLOGY—Tortrix eggs are deposited on upper leaf surfaces. First instars are active until mid-August, and feed gregariously within rolled leaves where they skeletonize both the upper and lower leaf surfaces. The larvae then migrate to protected areas, spin a shelter, molt to second instar and overwinter. The overwintered larvae become active during the first two weeks of May and mine into buds. Complete destruction of unflushed leaves can occur before bud burst. Larger larvae feed more openingly.

Pupae are formed within rolled leaves of the host plant and understory vegetation. The adults emerge and are active from late June to July.

As with many defoliators, *C. conflictana* populations rapidly increase to epidemic levels. Aspen stands are usually completely denuded for two consecutive years, then populations subside. Large aspen tortrix populations require a pure diet of aspen to maintain outbreak levels.

Complete stripping of aspen foliage before the last instar will reduce population numbers due to widespread starvation. Tortrix larvae cannot survive the two or more weeks required by aspen to refoliate and thus are forced to feed on plants that do not provide proper nutrition for larval development and egg production.

Weather, starvation, and parasitism are most effective in reducing *C. conflictana* populations.

REFERENCES—7, 8, 9, 12.

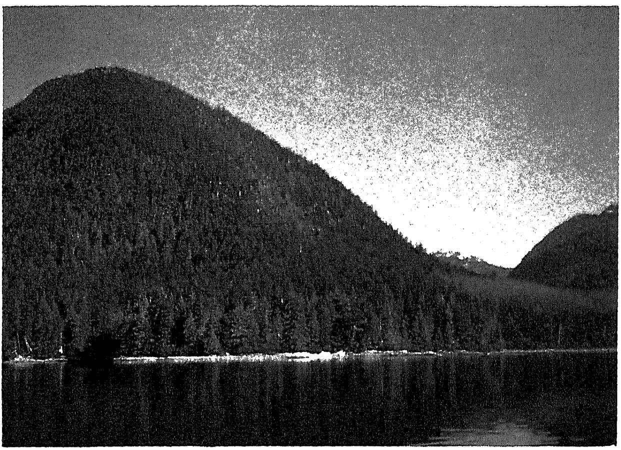


Figure 4—Hemlock defolitation, Calder Bay, southeast Alaska.

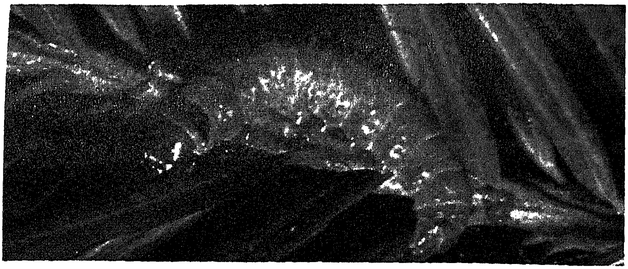


Figure 5—Blackheaded budworm larva, *Acleris gloverana.*

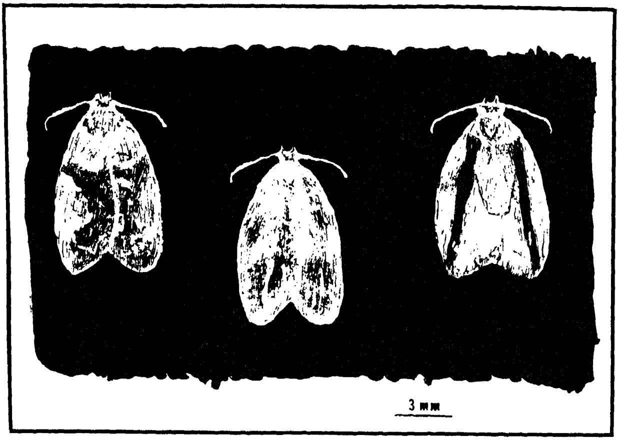


Figure 6—Blackheaded budworm color morphs, *A. gloverana.*

Figure 7—Spruce budworm damage, *Choristoneura* spp.

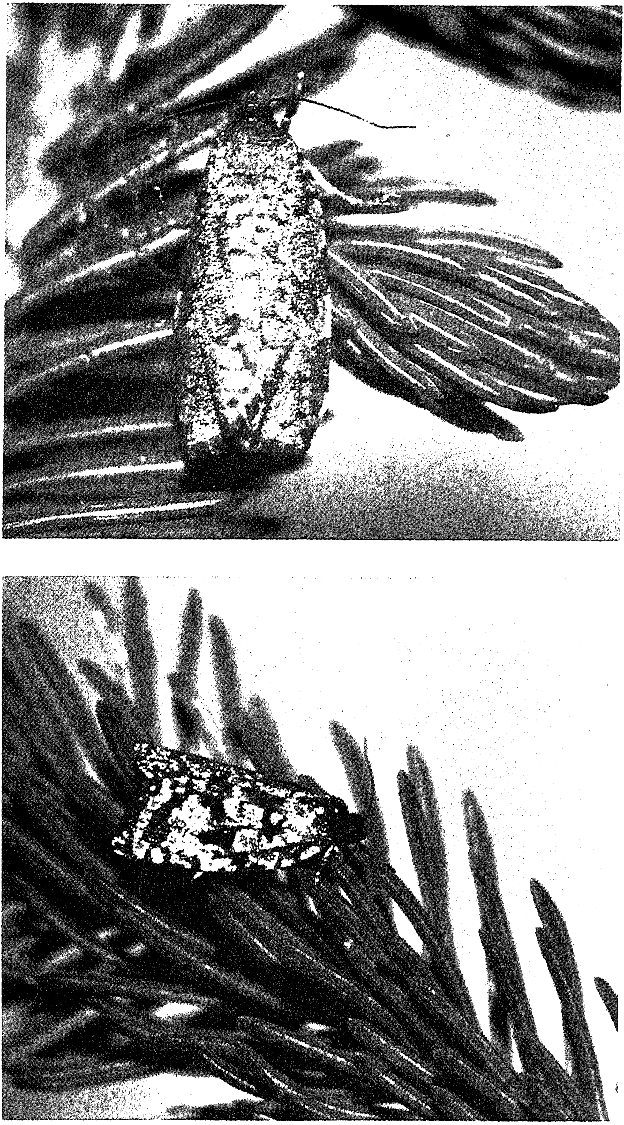


Figure 8—Adult spruce budworm color phases.

Figure 9—Spruce budworm larva, *Choristoneura* spp.

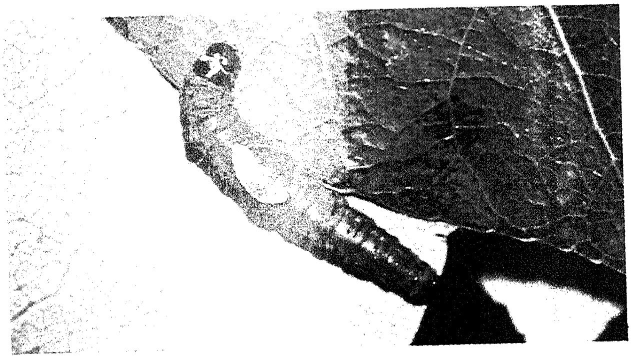


Figure 10—Late instar large aspen tortrix larva, *Choristoneura conflictana:* note parasitic fly maggot feeding on larva.

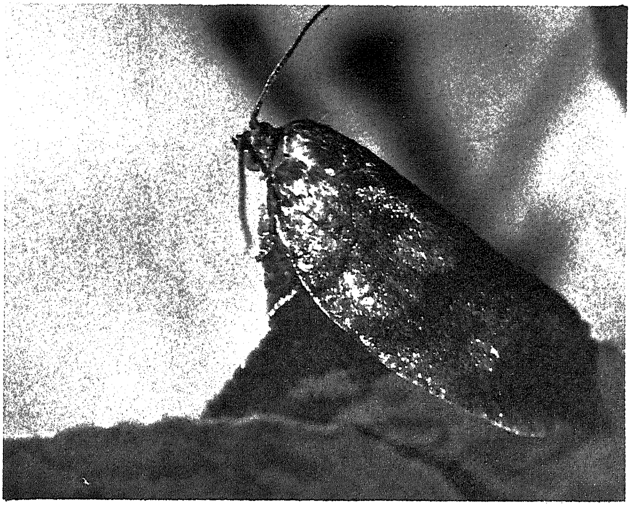


Figure 11—Large aspen tortrix adult, *C. conflictana.*

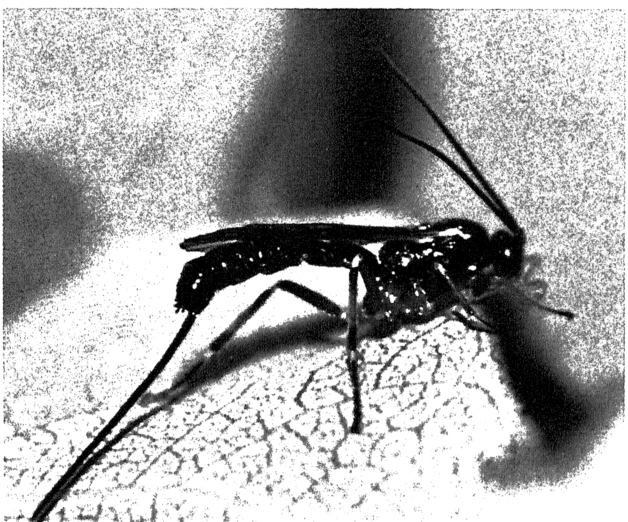


Figure 12—*Glypta inversa;* common large aspen tortrix parasite.

LEAF ROLLERS
LEPIDOPTERA: OLETHREUTIDAE
Epinotia solandriana L.

HOST—Paper birch, willow, alder, aspen.

DAMAGE—Larvae roll leaves which are skeletonized, curl, brown and drop prematurely. Branch dieback and tree mortality sometimes occur.

DISTRIBUTION—Recurrent problem in south-central and interior Alaska.

DESCRIPTION—Eggs are approximately 0.96 mm long by 0.71 mm wide, oval in shape and a reddish-orange. First instars are pale-green. Later instars are a blueish-grey turning to a pale yellow-cream prior to pupation. Pupae are brownish and are approximately 8.0 mm long and 2.5 mm wide. Adult moths vary in forewing pattern. The most common pattern (approximately 65 percent) is one of subdued greys and browns. Wingspan ranges from 1.5 to 2.0 cm.

BIOLOGY—*E. solandriana* has one generation per year in Alaska, and overwinters in the egg stage. Larvae emerge from mid-May to early June and begin feeding in buds and later in leaf rolls. Last instars vacate the leaf rolls and pupate in fragile cocoons between the humus layer and the mineral soil. The adults emerge from the end of July to August. After mating, eggs are laid singly on previous year's twigs, usually on the roughened bud stalks.

E. solandriana is the most common leaf roller on birch. However, other genera, including *Clepsis,* are commonly associated with *E. solandriana.* Leaf rollers are a recurrent problem in south-central and interior Alaska. However, drastic and repeated defoliation by these insects is required to kill birch. At worst, the insect attacks result in minor growth reduction and occasional branch dieback.

Large populations of leaf rollers are reduced by adverse weather, parasites, predators, and disease.

REFERENCES—43, 47.

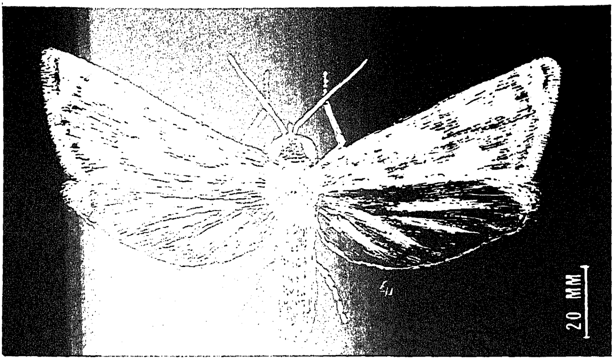


Figure 13—Leaf rollers.

Figure 14— [illegible] damage, *Epinotia solandriana*.

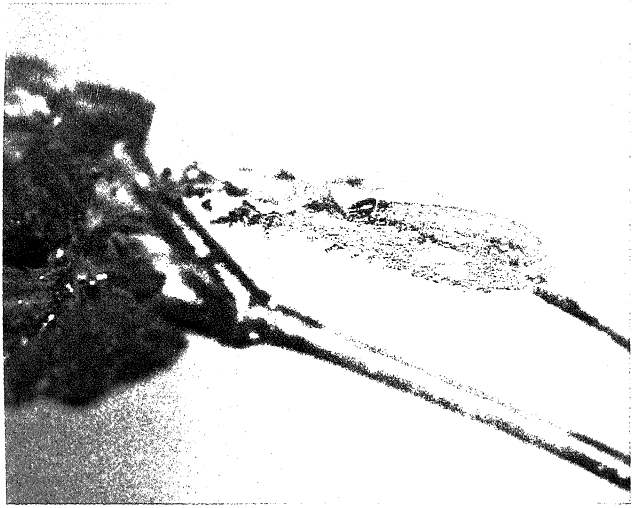


Figure 15—Mature leaf roller larva, *E. solandriana*.

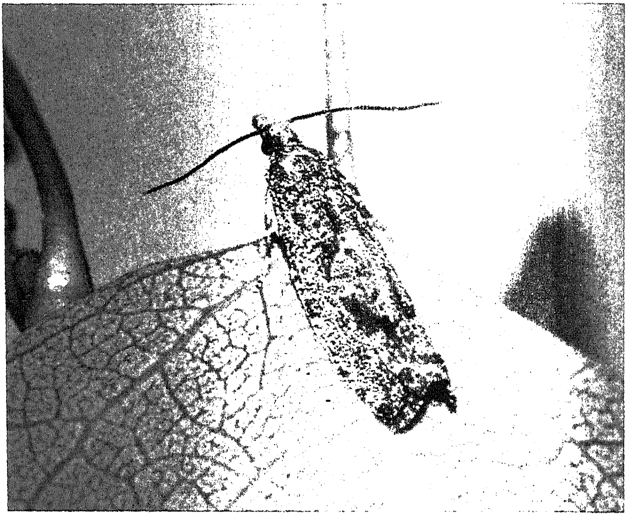


Figure 16—Most common adult leaf roller color pattern, *E. solandriana.*

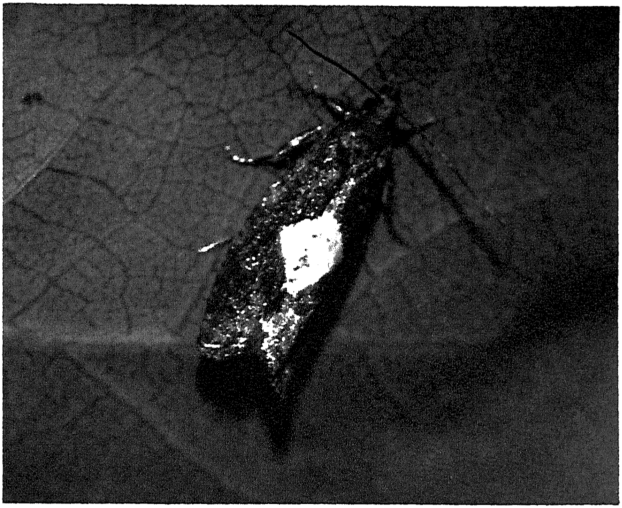


Figure 17—Variation in *E. solandriana* forewing pattern.

WESTERN HEMLOCK LOOPER
LEPIDOPTERA: GEOMETRIDAE
Lambdina fiscellaria lugubrosa (Hulst.)

HOST—Sitka spruce (preferred host in Alaska), Western hemlock, western redcedar, Alaska yellow cedar and alder.

DAMAGE—Severe defoliation causes reduction in tree growth, and at times, tree mortality.

DISTRIBUTION—The only recorded looper outbreak in Alaska occurred from 1965 to 1966 about 30 km southeast of Wrangell where approximately 200 hectares of Sitka spruce were heavily defoliated (one kilometer equals 0.62137 mile).

DESCRIPTION—Mature larvae are 2.8-3.2 cm long and brownish grey with various patterns of lines, stripes, and spots giving them a mottled appearance. Pupae are approximately 1.3 cm long, mottled greenish brown. Adults are light buff with a wing span of 3-5cm. Forewings are marked with two wavy lines and hindwings with one wavy line. Eggs are minute (about 0.6 mm long) and greyish green.

BIOLOGY—Eggs are deposited on the upper bole and branches and understory shrubbery where they overwinter. The larvae, called measuring worms or loopers, hatch in late spring and early summer and begin feeding on young needles in the crown. Later in the larval development old foliage is eaten. Often only a few bites are taken out of each needle.

Mature larvae pupate in the forest litter or in bark crevices. The pupal period is approximately two weeks. Adults emerge in late fall to mate and lay eggs. There is one generation per year.

Outbreaks build up rapidly and generally last for three years. A single complete defoliation at midsummer can cause mortality. Some trees can withstand 50 percent defoliation and even 75 percent defoliation is not fatal unless the trees are subsequently attacked by other insects such as bark beetles.

The most important natural controls are a virus disease and heavy rains during the period of moth dispersal. Eight species of parasites have been obtained from looper pupae.

REFERENCES—1, 16, 34, 35, 44, 60, 62.

SPEAR-MARKED BLACK MOTH
LEPIDOPTERA: GEOMETRIDAE
Rheumaptera hastata (L.)

HOST—Paper birch, alder, willow.

DAMAGE—Webbed leaves are heavily skeletonized. Severe defoliation by early August results in a temporary reduction in radial and terminal growth. Branch dieback is quite common. Repeated defoliation can result in tree mortality.

DISTRIBUTION—South-central and interior Alaska. From 1974-75, 1.1 million hectares of paper birch in interior Alaska were infested by epidemic populations of the spear-marked black moth.

DESCRIPTION—Adults are black moths with white markings on the wings, approximately 9-11.5 mm long with a wingspread

of 26-30.5 mm. Newly hatched larvae are 2.5 mm long and have grayish-green bodies and light-brown heads. Mature larvae are about 16 mm long and have black bodies with a whitish-pink spot on the sides of each body segment and dark-brown heads. Pupae are shiny brown and about 11 mm long and 3.5 mm wide.

BIOLOGY—There is one generation per year. Clusters of eggs are deposited from mid-June to early July on upper leaf surfaces or in folds of leaves that have been rolled by leaf rollers. Emerging larvae feed gregariously on upper leaf surfaces between two leaves that have been webbed together. Damage is often inconspicuous due to the larval behavior of webbing leaves together. Third and fourth instars singly web one or two leaves together and feed singly. Defoliation becomes readily apparent by early August.

Last instars drop to the forest floor, pupate and overwinter in forest litter. Adult moths emerge from early June to July. Following emergence, large groups of adults seek moisture.

Parasites, predators, disease, and weather are responsible for population declines. During the 1974-75 spear-marked black moth outbreak, apparent parasitism accounted for a 6-percent reduction of *R. hastata* larval populations and a 90-percent reduction of pupal populations. Likewise, disease contributed to a 95-percent reduction in third and fourth instar populations in 1975.

REFERENCES—34, 68, 69.

GREEN-STRIPED FOREST LOOPER
LEPIDOPTERA: GEOMETRIDAE
Melanolophia imitata (Wlk.)

HOST—Western hemlock (preferred host), western red and Alaska yellow cedar.

DAMAGE—Needle chewing can cause top kill and rarely tree mortality.

DISTRIBUTION—Southeast Alaska.

DESCRIPTION—Mature green-striped forest looper larvae are deep apple green with white and yellow-green lateral stripes. The head is pale green. Adults are mottled gray brown moths with a wing-span of 25-40 mm.

BIOLOGY—Not well known in Alaska. However, in British Columbia, this looper overwinters as a pupa in the duff layer. Adults emerge, mate and oviposit from mid-May to mid-June. Eggs are deposited on tree branches and trunks. Larvae will feed on foliage of all ages, but 1-year-old foliage is preferred. Feeding is heaviest in the upper crown. Mature larvae drop to the ground and pupate in late summer.

REFERENCES—27, 35.

SADDLE-BACKED LOOPER
LEPIDOPTERA: GEOMETRIDAE
Ectropis crepuscularia (Schiff).

HOST—Western hemlock (preferred host), western red and Alaska yellow cedar.

DAMAGE—Needle chewing can cause top kill and rarely tree mortality. This looper is commonly found in association with the hemlock sawfly. In 1969, this looper caused moderate to severe defoliation, and some mortality of western hemlock on 100 hectares near Ketchikan.

DISTRIBUTION—Southeast Alaska

DESCRIPTION—Nearly mature saddle-backed looper larvae have a distinctive inverted "V" on the second abdominal segment but this character is indistinct or missing in older larvae. Mature larvae are brownish with reddish diamond-shaped marks on the back. The mottled, light gray moth has a wing span of 30 mm.

BIOLOGY—Not well known in Alaska. However, in British Columbia, the moths emerge in May and lay eggs. Recently emerged larvae feed first on the ground cover and understory, later moving up into trees. Mature larvae drop to the ground in August where they pupate and overwinter.

REFERENCES—27, 35.

KODIAK LOOPER
LEPIDOPTERA: GEOMETRIDAE
Operophtera hyperboreata (Hulst.)

HOST—Alder, willow, cottonwood, elderberry, and high bush cranberry.

DAMAGE—Repeated defoliation can cause twig and branch mortality.

DISTRIBUTION—Present only on Kodiak, Afognak and Raspberry Islands. In the 1970's, Kodiak looper populations remained high for 3 consecutive years, then they collapsed.

DESCRIPTION—Larvae (about 20 mm long) crawling with a looping motion and are indistinguishable from small twigs. Adult males have a slender, light brown body and thin semi-transparent wings banded with brown. Wing expanse is 25-30 mm. Females are thought to be wingless.

BIOLOGY—Not known in Alaska. However, the biology of a related species (*O. bruceata* (Hulst.)) is well known and thought to be similar to *O. hyperboreata*. Eggs are laid singly in bark crevices in the fall. Larvae hatch when the buds burst. Larval development is completed by late June or early July. Pupation occurs in the soil. Adults emerge and mate in the fall. There is one generation per year.

REFERENCES—5, 27.

Figure 18—Western hemlock looper larvae, *Lambdina f. lugubrosa.*

Figure 19—Western hemlock looper pupa, *L. f. lugubrosa.*

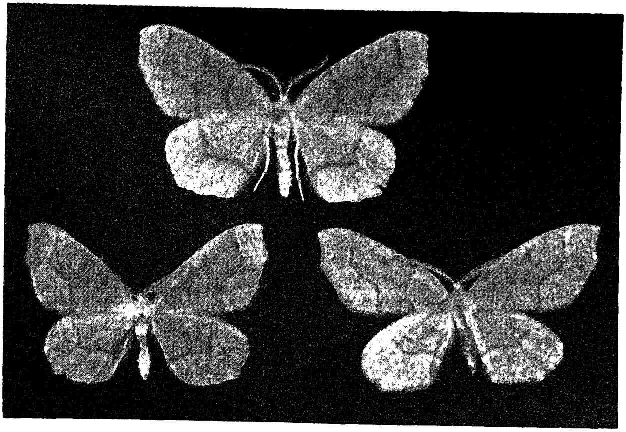


Figure 20—Adult western hemlock loopers.

Figure 21—Birch defoliation near Fairbanks because of the spear-marked black moth, *Rheumaptera hastata*.

Figure 22—Recently emerged spear-marked black moth adults, *R. hastata,* seeking moisture.

Figure 23—Green-striped forest looper larva, *Melanolophia imitata.*

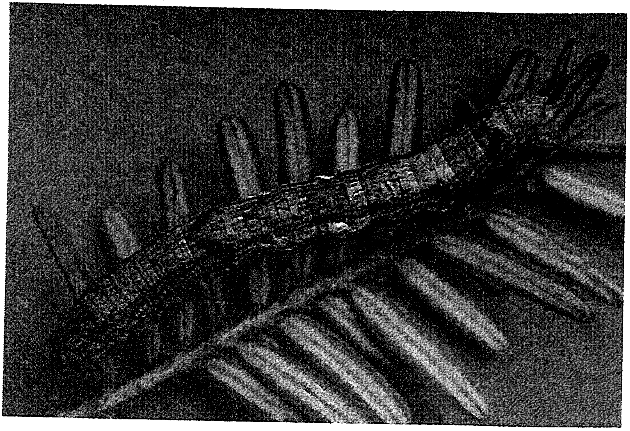


Figure 24—Mature saddle-backed looper larva, *Ectropis crepuscularia.*

Figure 25—Adult saddle-backed looper, *E. crepuscularia.*

SPRUCE AND LARCH BUDMOTH
LEPIDOPTERA: OLETHREUTIDAE
Zeiraphera spp.

HOST—White spruce and eastern larch (tamarack).

DAMAGE—New buds are mined by developing larvae.

DISTRIBUTION—South-central and interior Alaska.

DESCRIPTION—Adults are small, greyish to brownish moths, with a wingspread of about 14mm. Larvae are 10-20 mm long, pale brown to greenish grey and the head and pronotum are yellowish-brown.

BIOLOGY—Not well known in Alaska. In 1976, the larch budmoth (closely related to *Z. improbana* (Walk.)) was responsible for the defoliation of 239,000 hectares of larch in interior Alaska. The trees did not die because defoliation occurred in the spring and the infested larch were able to refoliate soon after. The larch budmoth overwinters as eggs under bark scales of twigs and branches of tamarack trees. Newly emerged larvae feed within a webbed tube constructed from several newly formed needles. Fourth and fifth instars live in lightly spun silken shelters along the branch axis and travel along the branch feeding on new and old needles. Larvae drop to the ground on silken threads and pupate in the forest litter. Females emerge and deposit eggs in late July. There is one generation per year.

REFERENCES—17, 18, 27, 43, 71.

LEAF BLOTCH MINER
LEPIDOPTERA: GRACILARIIDAE
Phyllocnistis populiella (Chamber)
Lithocolletis ontario Freeman

HOST—Aspen, balsam poplar, alder.

DAMAGE—Meandering mines produced in epidermal layers on underside of leaves. Such mining reduces the photosynthetic area of the affected leaves. Heavy repeated attacks reduce tree growth and can kill trees.

DISTRIBUTION—South-central and interior Alaska.

DESCRIPTION—Adults are minute moths with lanceolate wings. Larvae are minute (approximately 5 mm long), white, very flat and are found within meandering mines.

BIOLOGY—Winter is spent as adults under bark scales of conifers and hardwood trees. Adults emerge early June and deposit eggs singly on the leaf edge then slightly fold the leaf edge to form a protective covering for the egg until larval emergence. The newly hatched larvae bore and feed between epidermal leaf tissues. After the fourth instar, pupation occurs within the mines made in the leaf. Adult emergence occurs prior to or sometimes after the leaves drop in late August and early September.

REFERENCES—7, 14, 27, 44, 71.

HEMLOCK SAWFLY
HYMENOPTERA: DIPRIONIDAE
Neodiprion tsugae (Midd.)

HOST—Primary host is western hemlock.

DAMAGE—Feeds on old foliage resulting in a reduction in host radial growth. Some top-kill is evident.

DISTRIBUTION—Hemlock sawflies occur throughout southeast Alaska. However, sawflies are more abundant and outbreaks are longer lasting in southern southeast Alaska where widespread damage is usually confined to the area south of Frederick Sound especially along Clarence Strait, the warmest area in southeast Alaska.

DESCRIPTION—Adult sawflies are small, thick-waisted wasps about 5-8 mm long. Females are larger than males and have serrated antennae, whereas males are black and have plumed antennae.

Newly emerged larvae are nearly all black, but later instars turn dark green. When larvae are nearly full grown, longitudinal stripes appear. Larvae of all instars have black head capsules. Mature larvae are 15-20 mm long.

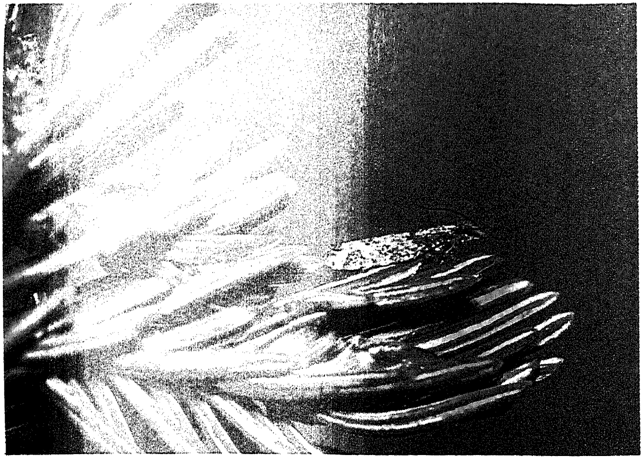


Figure 26—Adult spruce budmoth, *Zeiraphera* spp.

Figure 27—Larval galleries of the aspen leaf miner, *Phyllocnistis populiella*.

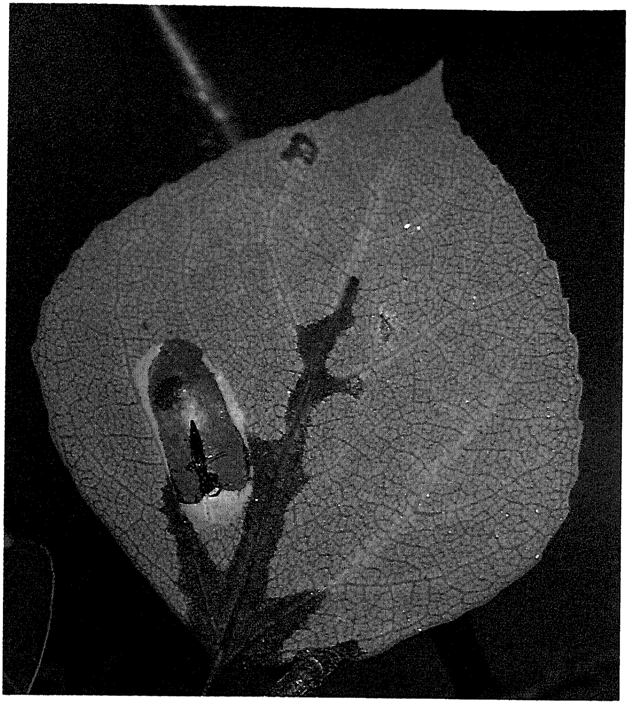


Figure 28—Blotch miner gallery and pupal case, *Lithocolletis* spp.

Figure 29—Adult blotch miner, *Lithocolletis* spp.

BIOLOGY—Adults emerge and are active in September and October. Sawflies normally overwinter as eggs on host foliage, but rare individuals overwinter as cocooned pupae in forest litter. Eggs are deposited singly in characteristic pockets cut into edges of hemlock needles. Eggs hatch in June and larvae feed gregariously on old foliage. Larvae pupate in capsule-like cocoons on foilage or in litter during August and September.

Most sawfly outbreaks do not cause tree mortality, but some trees are top-killed and radial growth is temporarily reduced. Tree mortality becomes more apparent when sawfly and black-headed budworm populations coincide. This is due to the feeding habits of the two defoliators; the budworm feeds on current year's foliage, whereas sawflies consume old foliage, causing complete defoliation. Sawfly larvae cannot successfully complete development on the current year's foliage.

Natural controls usually reduce epidemic sawfly populations within a few years. Wetter than normal summers help reduce sawfly populations by favoring conditions for fungal growth. Fungi readily infect and kill sawfly larvae under warm, damp conditions. Likewise, low summer temperatures help reduce sawfly populations. The apparent widespread collapse of sawfly populations in southeast Alaska in 1974 was associated with lower than normal 1973 temperatures. Low temperatures delay sawfly development and reduce the opportunities for successful oviposition. Starvation and poor nutrition brought about by a depletion of host foliage contribute to population collapse by reducing sawfly health (increasing effectiveness of fungal infection) and fecundity (the number of eggs laid).

REFERENCES—35, 37, 38.

STRIPED ALDER SAWFLY
HYMENOPTERA: TENTHREDINIDAE
Hemichroa crocea (Fourcroy)

HOST—Alder.

DAMAGE—Repeated defoliation can cause some host growth reduction.

DISTRIBUTION—Southeast Alaska. In 1971 and 1972, the striped alder sawfly infested young alder stands near Juneau.

DESCRIPTION AND BIOLOGY—Not well known in Alaska. In British Columbia there are two generations per year. Eggs are laid in a row on the underside of the leaf midrib. The larvae are gregarious and chew holes through the leaf from the underside. When disturbed or while feeding, larvae often assume a fishhook posture with the posterior end curled under and upward. Fullgrown larvae are 20mm long with a black head and a yellow-amber body marked by dark brown lateral stripes.

REFERENCES—27, 31, 35.

LEAF BEETLES
COLEOPTERA: CHRYSOMELIDAE
Chrysomela scripta, C. interrupta *Phratora* spp., and *Altica bimarginata*

HOST—Quaking aspen, birch, alder, and willow.

DAMAGE—Adults feed on tender shoots. Larvae first skeletonize and later chew holes in the leaves.

DESCRIPTION—Adults are variously colored, either brown, green, reddish brown, yellowish green, and with or without black spots. They are approximately 0.5 cm long and oval. Newly hatched larvae are flattened, dark grubs with well developed legs. The eggs are yellowish red.

BIOLOGY—Not well known in Alaska. Leaf beetles overwinter as adults in leaf litter. Adult leaf beetles become active in early spring and feed on tender shoots. Eggs are deposited on the upper and undersurface of leaves. Newly emerged larvae feed gregariously during the first three instars. There is probably one generation per year in Alaska.

REFERENCES—71.

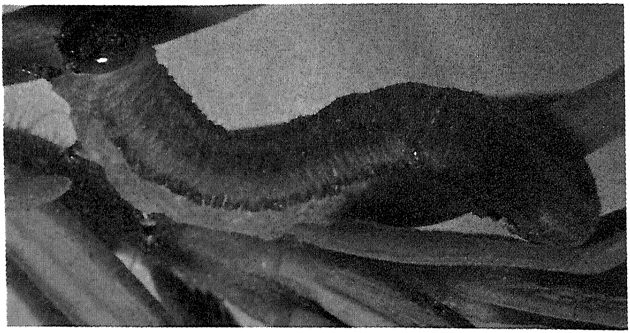


Figure 30—Hemlock sawfly larva, *Neodiprion tsugae.*

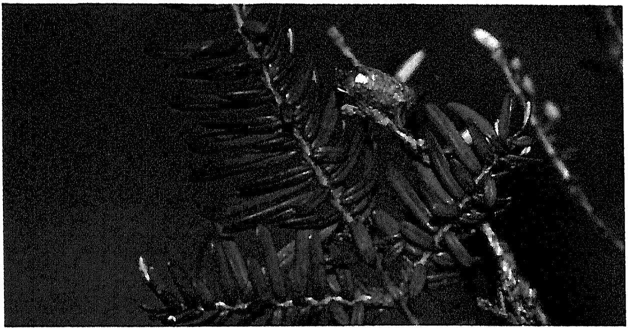


Figure 31—Hemlock sawfly pupa, *N. tsugae.*

Figure 32—Adult hemlock sawfly female, *N. tsugae.*

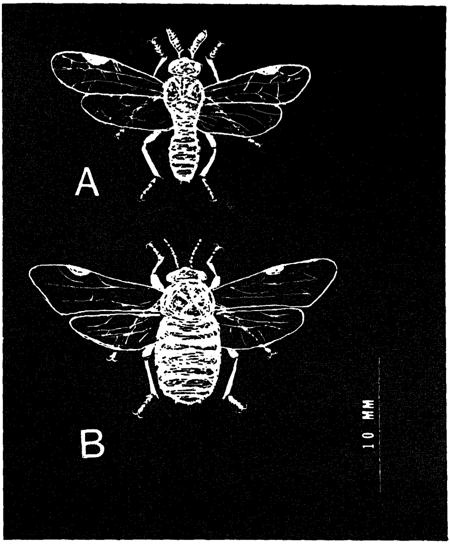


Figure 33—Hemlock sawfly adults: A. Male; B. Female.

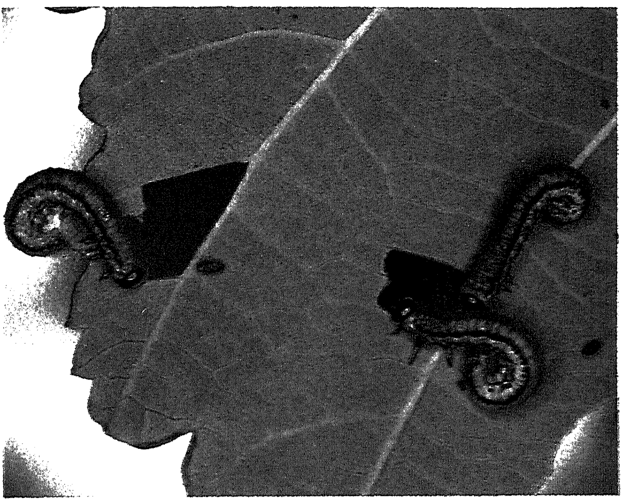


Figure 34—Striped alder sawfly larvae, *Hemichroa crocea*.

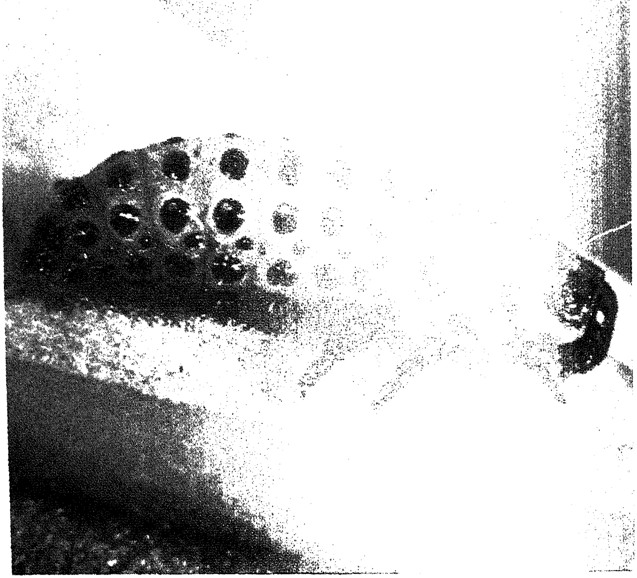


Figure 35—Leaf beetle larva, *Chrysomela* spp.

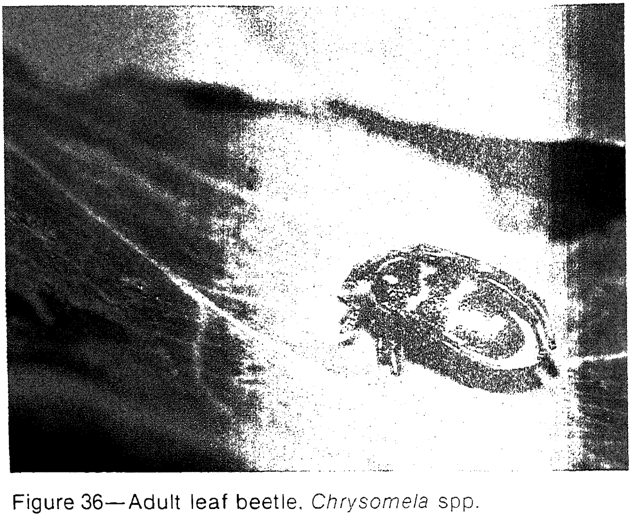


Figure 36—Adult leaf beetle, *Chrysomela* spp.

They are more important as pests in orchards, gardens, or to shade trees than they are in the forest. Hosts are injured in two ways:

• Directly by sapping the host of part of its food supply and water, producing necrotic spots in host tissue.

• Indirectly by introducing plant diseases.

The mouthparts of these animals are formed into beak-like structures which are used to pierce host tissues and suck the sap. Their injury is less severe than that of other forest insects. Damage by sap-sucking insects is often mistakenly regarded as disease-caused. A few of the sap-sucking insects are able to kill their hosts outright, but damage usually results in reduced growth rates and a general weakened condition. Trees injured by these insects may succumb to secondary insects or fungal diseases.

Signs of sap-sucking insect injury consist of enlarged growths or galls, leaf curling, bleaching, or yellowing of foliage. Conifers are more severely injured than hardwoods.

In Alaska, there are several sap-sucking insects which cause noticeable damage to trees and shrubs. These pests can cause appreciable problems to urban woodlands and parks. The following key will aid in the identification of these pests. Special care and use of a hand lense will help in detection and identification as these insects are quite small.

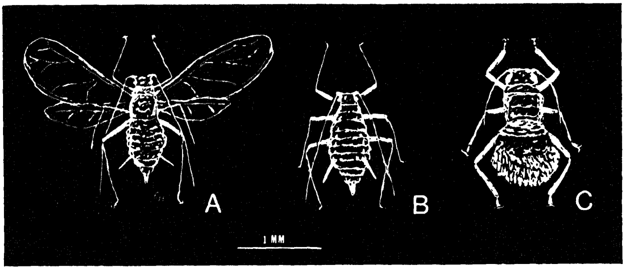


Figure 37—Aphids: A. Adult; B. Nymph; C. Woolly aphid nymph.

Identification Key

1. Damage on Spruce ____ 2

1'. Damage on Western Hemlock and Hardwoods ____ 5

2. Damage consists of greenish purple to black galls when aphids are developing-brown after departure of adults; on new growth on branch ends; commonly mistaken as immature cones. Nymphs found inside of chambered galls ____ Spruce Gall Aphids *Adelges* or *Pineus*

2'. Damage not as above ____ 3

3. Frothy, spittle-like masses on spruce seedlings ____ Spittlebug

3'. Affected foliage fading to brownish red, followed by premature needle cast. Whitish insect "skins" may be present. Insects small, 5 mm or less ____ 4

4. Adult insects are dull green, with antennae, about 5mm when mature; cornicles present. Honeydew may be present in large quantities ____ Spruce Aphid *Elatobium abietinum*

4'. Adults quite small, spider-like (about 0.5 mm) and lacking antennae; damage similar to that of the Spruce Aphid; usually problematic in nurseries and urban situations; webbing may be present on infested foliage. ____ Spider Mites *Paratetranychus* and *Tetranychus*

5. Leaf-curling and browning with large quantities of honeydew present; damage quite apparent on birch ____ Birch Aphid *Euceraphis sitchensis*

5'. Galling and woolly material apparent on hemlock and aspen ____ 6

6. Woolly material on western hemlock ______________________________ Hemlock Woolly Aphid *Adelges tsugae*

6'. Woolly material and galling on aspen ______________________________ Gall and Woolly Aphids *Mordwillkoja* spp. *Pemphigus* spp. *Cinara* spp.

SPRUCE APHID
HOMOPTERA: APHIDIDAE
Elatobium abietinum (Wlkr.)

HOST—Feed on most species of spruce, but are most damaging on Sitka spruce.

DAMAGE—Partial or complete defoliation and occasional tree mortality.

DISTRIBUTION—Spruce aphid populations have infested several areas of southeast Alaska causing severe defoliation and tree mortality. Serious damage has sporadically occurred near Sitka where several hundred trees have been killed. The more severely defoliated trees were weakened and attacked by bark beetles which had built up in adjacent windthrows.

DESCRIPTION—Eggs are yellow-red to dark brown or black, oval, and about 0.6 mm long. Nymphs are oval, green and wingless, approximately 0.5-1.4 mm long. Adult aphids may be either wingless or winged. Wingless adults are about 1.5 mm long, oval, green, with a yellow-green head and dull red eyes. Winged adults are bright green with pale green or pale brown legs. The transparent wings are longer than the body which is approximately 1.0-.18 mm long.

BIOLOGY—There are two damaging life stages; nymph and adult. Aphids generally overwinter as eggs. Females are more common than males. The spruce aphid leaves Sitka spruce for an alternate host, then reappears on Sitka spruce the following spring. The alternate host is unknown in Alaska.

Natural control factors such as parasites, starvation, and harsh winter help reduce spruce aphid populations before widespread damage occurs.

Control of spruce aphids on shade and ornamentals can be done with commercially available insecticides labeled for aphid control.

REFERENCES—20, 35, 42.

SPRUCE GALL APHID
HOMOPTERA: ADELGIDAE (=CHERMIDAE)
Adelges spp. and *Pineus* spp.

HOST—Sitka and white spruce.

DAMAGE—Tip galling results in stunted and deformed trees.

DISTRIBUTION—Spruce gall aphids have been active at a few locations on the Kenai Peninsula, Anchorage, and southeast Alaska.

DESCRIPTION—Adults are oval, reddish brown, and 1 mm long. Nymphs are oval, reddish to yellowish brown and covered with a white woolly material. The new cone-like galls are green-purple, but later become dry and brown.

BIOLOGY—Adelgids are closely related to aphids. They differ from aphids in several respects. Adelgids have very reduced or no cornicles; both the parthenogenetic and sexually perfect females lay eggs.

Single fertilized eggs are deposited on branch tips and spruce nodes in late summer and hatch shortly afterwards. The nymphs are oval, reddish to yellowish brown and are covered with a white woolly material. They overwinter below buds or the underside of spruce branches. The following spring they transform into adult females. The gall forming summer generation of aphids emerges late in May and moves to spruce new growth. Their feeding produces the green-purple galls in which they live. The adults mature in approximately 2 months, leave the galls, and fly to a secondary host.

The cone-like galls develop rapidly; sometimes requiring only a few days to become full grown. When the galls become dry and brown in appearance, the aphids have left.

The gall aphid was described from Alaska as *Adelges cooleyi* (Gill), but this identification seems questionable. *A. cooleyi* has a secondary host, Douglas-fir, which is not native to Alaska. Survival of *A. cooleyi* on spruce alone is questionable. However, *Pineus similis* (Gillette) has been identified as forming galls on white and Sitka spruce in Canada. Thus, it is possible that this aphid exists on Alaska spruce.

Removing and burning **green** galls is an efficient control for high value trees if done before aphid adult emergence in early summer.

REFERENCES—17, 27, 41, 44.

HEMLOCK WOOLLY APHID
HOMOPTERA: ADELGIDAE (=Chermidae)
Adelges tsugae Annand.

HOST—Western hemlock.

DAMAGE—Woolly tufts on needles and/or bark, yellow-spotting of needles. This species is of little consequence in the forest but seriously weakens and sometimes kills ornamental trees.

DISTRIBUTION—Throughout southeast and south-central Alaska.

DESCRIPTION—Nymph is broadly ovoid, 0.3 mm to 0.6 mm long; yellow to brown when young. Later stages are dark brown to black, covered with white, waxy wool.

BIOLOGY—Biology is unknown in Alaska. However, in Canada and the Pacific Northwest, a one year life cycle is common. Only hemlock is fed upon. Populations probably consist only of females which are able to reproduce asexually.

REFERENCES—27.

Figure 38—Spruce aphid, *Elatobium abietinum,* damage on Sitka spruce, Sitka, Alaska.

Figure 39—Spruce gall aphid damage on white spruce.

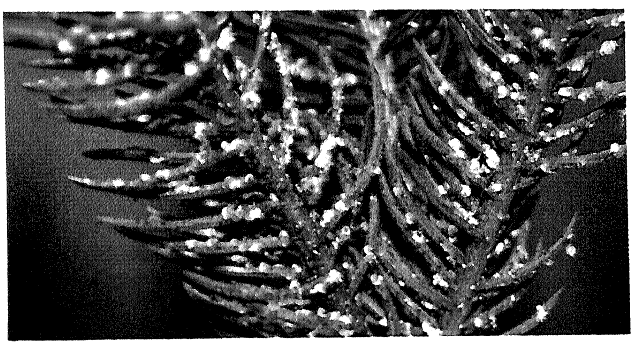


Figure 40—Woolly aphids on white spruce.

BIRCH APHID
HOMOPTERA: APHIDIDAE
Euceraphis sitchensis Glenn.

HOST—Paper birch.

DAMAGE—Leaf-curling and browning.

DISTRIBUTION—Large aphid populations on paper birch caused concern in the Anchorage area during the summer of 1975. Browning of birch foliage covered more than 50,000 hectares near Chickaloon and down the Matanuska River. The next summer, various species of aphids were present in high numbers in mixed hardwood and spruce hardwood stands covering nearly 120,000 hectares near Palmer urban areas. They were responsible for large amounts of honey-dew, leaf-curling and browning on ornamental birch in both cities.

DESCRIPTION—Small, greenish brown aphid's; both winged and wingless forms may be present.

BIOLOGY—Unknown in Alaska.

REFERENCES—5, 43.

OTHER APHIDS
Ericosoma spp.
Mordwilkoja spp.
Pemphigus spp.
Cinara spp.

The above generally cause some leaf-curling and browning and some limited dieback on aspen throughout interior Alaska. They are commonly encountered in the field although their damage is of minor concern.

REFERENCES—7, 71.

SPITTLEBUG
HOMOPTERA: CERCOPIDAE

HOST—Sitka spruce seedlings.

DAMAGE—Dead tops, flagged branches, wavy and slanted stems, shortened stem and branch internodes.

DISTRIBUTION—Southeast Alaska (Petersburg).

DESCRIPTION—Young nymphs are red and black; older ones are brown. Adults are brown to black and similar to nymphs but with wings. Eggs are teardrop in shape. Both the adult and nymph feed on plant fluids; only nymphs make spittlemass which serves as a protective covering.

BIOLOGY—Unknown in Alaska.

REFERENCES—20, 73.

SPIDER MITES: ACARINA
Paratetranychus spp. and *Tetracychus* spp.

HOST—Conifers and hardwoods.

DAMAGE—Fading host foliage which turns brown and then falls prematurely.

DISTRIBUTION—Throughout Alaska; prevalent in urban areas.

DESCRIPTION—Adults are 0.5 mm long with a globular body, four pairs of legs, and no antennae. The spider-like adults are greenish to reddish-brown. Nymphs are similar to adults but have only three pairs of legs.

BIOLOGY—Unknown in Alaska. Generally spider mites overwinter as eggs or adults. There are many generations per year. Females can lay from two to four dozen eggs. The presence of mites can be detected by webbing on the foliage which contains considerable debris. Adults, due to their small size, can be detected only with a hand lens.

REFERENCES—1, 73.

Figure 41—Discoloration because of feeding of the birch aphid, *Euceraphis sitchensis.*

Figure 42—Spider mite damage.

Bark Beetles

The bark beetles are one of the most destructive groups of insects in Alaska, if not the entire United States. In the United States, ninety percent of insect caused tree mortality and more than sixty percent of the total insect caused loss of wood growth is due to bark beetles (1). Ninety percent of this loss has occurred in the western states where over-mature timber is still abundant.

Bark beetles annually destroy approximately 2 million cubic meters of spruce sawtimber in the United States (74). From the late 1960's through 1977 bark beetle infestations on the Kenai Peninsula (Alaska) covered about 107,810 hectares of white spruce. Likewise, during the same years, the estimated bark beetle-caused mortality on the west side of Cook Inlet covered more than 115,022 hectares (3).

There are many genera and species of bark beetles in Alaska. As a group, there are certain traits and habits that are common to all of them:

- Adults excavate egg galleries in bark phloem.
- Most bark beetles are secondary. That is, they prefer weakened host material. However, some can become primary pests by attacking healthy trees.
- All bark beetle life stages are spent in the phloem, innerbark and bark, except when adults leave the tree in which they developed to fly to new host material. Bark beetles feed on the phloem during adult and larval stages.

Bark beetles prefer to breed in weakened host material. However, during favorable climatic periods for beetle development, populations may build rapidly and healthy trees are successfully attacked. Bark beetles girdle the phloem which, in turn, disrupts the downward translocation of nutrients. Some of the bark beetles, notably those of the genus *Dendroctonus*, have a symbiotic relationship with blue-stain fungi. The blue stain fungi can completely penetrate the sapwood within a year. The fungi occlude the outer conducting tissues in the xylem which halts upward water translocation. This action, plus that of the bark beetles, causes the death of a host tree.

Crowns of heavily infested trees turn from green to yellow to reddish brown. This color change, an indication of a dying tree, may occur from one to two years depending on the temperature, moisture conditions, and density of beetles in the tree (71). Close inspection of infested tree trunks will show either small globules of resin, small holes through the bark, or reddish boring dust in bark crevices and around the tree base. The removal of bark from infested trees will reveal two types of galleries: Egg galleries constructed by adult beetles are rather uniform in width; larval galleries, on the other hand, depart from the egg gallery and increase in size as the young grow.

The following key will aid readers in obtaining the appropriate identification, biological, and control information.

Identification Key

1. Damage confined to white spruce, Sitka spruce, and occasionally on black spruce ________ 2

1'. Damage confined to western hemlock, western red and Alaska yellow cedar, and larch (tamarack) ________ 5

2. Egg galleries short, 6-23 cm long; vertical and slightly curved and broad, about .60 cm wide. Approximately half of the egg gallery is packed with boring dust and frass. Adult beetles are reddish brown to black and .50 cm long; coarse, reddish brown boring dust found in bark crevices and around the tree base. ________ Spruce Beetle
Dendroctonus rufipennis

2'. Egg galleries narrower than .25 cm ________ 3

3. Adult beetle .25-.40 cm long; head not visible when insect is observed from above; posterior end concave in sideview with spines in the concavity. Enlarged nuptial chambers in the inner bark adjacent to each entrance hole. Three to five egg galleries, free of frass, originating and radiating out from each nuptial chamber. Engravers
Ips

3'. Adult beetles are reddish brown to black, approximately .25 cm long. Larval galleries are narrow, short and quite irregular. Adults and young concentrated under bark on warm, exposed sides of host material ______ 4

4. Small (.25 cm) dark beetles with eyes almost completely divided giving the appearance of having four eyes. Egg galleries full of frass ______ 4-eyed spruce bark beetle *Polygraphus*

4'. Eyes not divided ______ *Dryocoetes*

5. Damage on tamarack (Larch), adult beetle reddish brown to black, 0.12-0.25 cm long. Egg galleries are vertical, approximately 20-25 cm in length. Larval tunnels occur in groups of 3-6, sometimes more, and do not cross one another. ______ Eastern Larch Beetle *Dendroctonus simplex*

5'. Damage confined to western hemlock, western red cedar or Alaska yellow cedar ______ 6

6. Short egg galleries located at right angles to the grain; larval galleries go with the grain. On western hemlock ______ Hemlock hylesinus *Pseudohylesinus tsugae*

6'. Typical egg galleries consist of one short, longitudinal gallery usually free of frass and boring dust, with eggs placed uniformly along the sides. Larval galleries are at right angles to the egg galleries. Damage confined to cedar ______ Cedar Bark Beetle *Phloeosinus squamosus*

SPRUCE BEETLE
Dendroctonus rufipennis (Kby.)

HOST—Sitka, white spruce and rarely black spruce.

DAMAGE—Kills standing trees.

DISTRIBUTION—Wherever spruce is present, especially in south-central Alaska.

DESCRIPTION—Adult spruce beetles are dark brown to black, cylindrical in shape, approximately 5 mm long and 3 mm wide. The larvae are stout, white, legless grubs, 6 mm long at maturity. The pupae are white, soft-bodied, and adult shaped.

BIOLOGY—The life cycle of the spruce beetle in Alaska is not definitely known, but is believed to be two years in duration. The following information applies to spruce beetle in the Rocky Mountains. Adult and larval activity begins in May when under the bark daytime temperatures reach about 8 °C (47 °F). Recently emerged adult beetles disperse in search of susceptible host material during late May and early June when daytime ambient temperatures are at least 16 °C (61 °F). Dispersing adults can fly long distances, over seven miles nonstop. Adult mortality during dispersal may exceed 50 percent. Females are attracted to windthrow and other downed material and begin the attack; males arrive later.

Beetles prefer to begin attack on the sides and bottoms of downed material. Under such conditions, temperature and moisture regimes are favorable for brood development and survival. Unpublished data indicate that windthrown trees can remain attractive through two attack periods. Males and other females are attracted via sex and aggregating pheromones. *D. rufipennis* is monogamous, and females deposit eggs in niches along the sides of the vertical egg gallery in a standing tree. Egg galleries, except for the terminal portion, are packed with frass and boring material. Most eggs hatch by August.

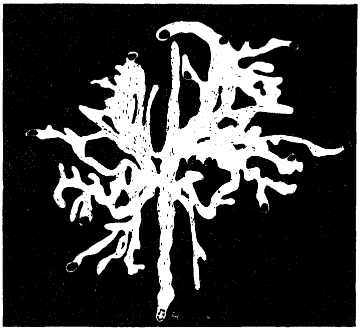


Figure 43 —Spruce beetle galleries.

Larvae predominate during the first overwintering period, although other life stages may be present. Most of the larvae pupate in the following summer; the pupal period lasts 10-15 days. The adults may overwinter in their pupal sites or migrate to the base of infested trees. This migration is an adjustment to cold temperature survival. The following spring (approximately two years after attack) adults emerge and attack new host material. In general, females only attack once.

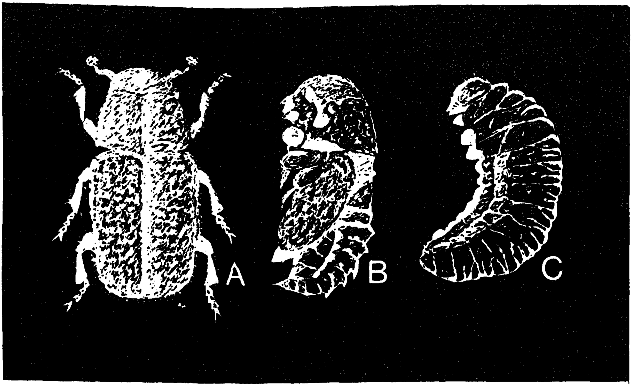


Figure 44—Spruce beetle life states: A. Adult; B. Pupa; C. Larva.

Most *D. rufipennis* outbreaks in standing timber have originated in blowdowns although logging residuals (cull logs) may be a contributing factor. In the Rocky Mountains and probably Alaska, the susceptibility of standing spruce decreases in the following order: (1) Large diameter trees along creek bottoms, (2) better stands on benches, (3) poorer stands on ridges and benches, (4) mixtures of spruce and other species, and (5) stands of immature trees.

In the lower 48 states, parasites and predators help reduce and maintain spruce beetle populations at low levels. However, the effect of predation and parasitism on spruce beetle populations in Alaska is not known. In the Rocky Mountains, Northern 3-toed, hairy, and downy woodpeckers can consume 40-98 percent of beetle brood during outbreak conditions. These predators are quite common in Alaska in beetle

infested areas and probably contribute to the decline of epidemic insect populations. Low temperatures are effective controls if the cold spells occur early before the insects become cold hardy.

CONTROL—Sanitation measures are effective in reducing bark beetle problems. When logging infested areas, stumps should be cut as low as possible as spruce beetles can breed in high stumps. Cull logs and large diameter slash (10.5 cm) should be disposed of. After limbing, cull logs and tops should not be piled, but positioned away from any shade. If subsequent evaluation shows high beetle populations breeding in such material, they should then be exposed to solar heat, burned, or debarked.

Another applied control is the use of "Trap-Trees", which are felled prior to beetle flight. Such material is highly attractive to dispersing spruce beetles. After the beetles have entered the trap logs, the logs are then burned, or debarked and salvaged. Caution is required to prevent bark beetles from emerging at the mill and infesting neighboring stands.

The above applied controls are applicable under selective, shelterwood, or clearcut silvicultural systems. A selective cutting system offers more shade for the residuals than does a clearcut. As spruce beetles prefer shaded host material, prompt removal of beetle infested trees and residuals may be the best guideline under a selective system. Any method that removes overmature trees and promotes vigorous growth of younger trees is desirable.

In summary, some cause of infestations that can be avoided through removal are:

- High stumps, cull logs and large diameter slash, and all shaded slash.

- Windthrown trees at edges of logging areas.

- Trees felled for logging road construction.

Susceptibility of spruce stands to beetle attack depends in part on favorable climatic conditions for brood development, availability of host material (large diameter old growth, blowdown) or spruce stands weakened by defoliation, flooding, or prolonged drought.

REFERENCES—3, 26, 33, 35, 52, 55, 56, 70, 72, 74.

Figure 45—Adult spruce beetle, *D. rufipennis.*

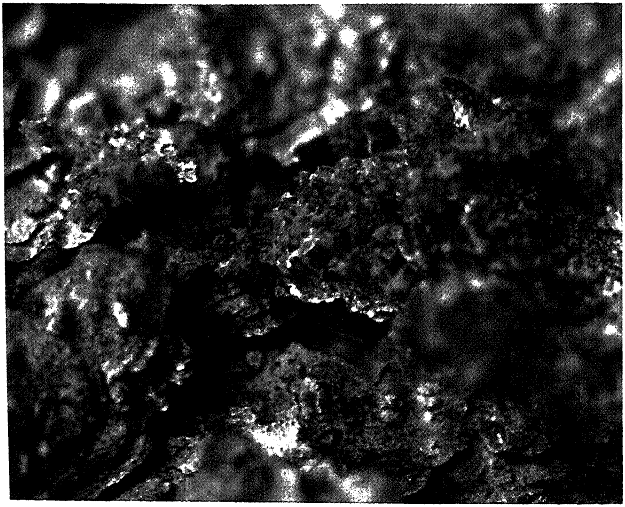


Figure 46—Spruce beetle boring material (frass) deposited in bark crevices.

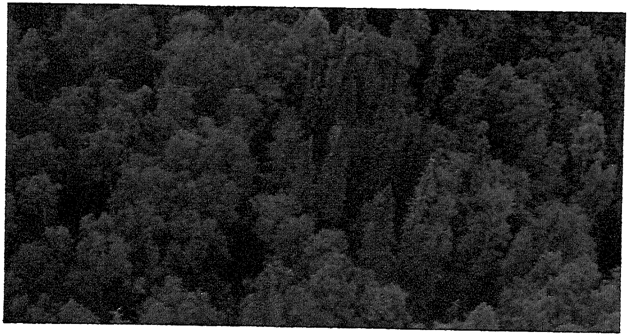


Figure 47—Fading dead white spruce killed by the spruce beetle, *Dendroctonus rufipennis.*

Figure 48—Powerline "right-of-way"; downed white spruce is being attacked by the spruce beetle.

Figure 49—Acceptable "right-of-way" cleanup.

EASTERN LARCH BEETLE
Dendroctonus simplex LeC.

HOST—Tamarack (Eastern larch).

DAMAGE—Attacks weakened tamarack and subsequently causes host mortality.

DISTRIBUTION—Interior Alaska. During an aerial reconnaissance in 1973 yellowing tamarack approximately 150 miles southwest of Fairbanks was noted. Affected trees were widely scattered over 47,063 hectares. In 1977, this infestation contained scattered larch mortality on almost 215,297 hectares.

DESCRIPTION—Adults and larvae are similar to the spruce beetle although somewhat smaller. Adults are reddish brown to black.

BIOLOGY -Adults are active from the last week of May through the second week of July. Pitch-tubes occur rarely on infested tamarack because of the host's weakened condition at the time of attack.

Egg galleries are vertical and approximately 20-25 cm in length. Larval tunnels occur in groups of 3-6 or more and do not cross. Larch beetles usually overwinter as adults under host bark at the base of the tree, although some larvae may overwinter. Overwintering larvae emerge in July.

REFERENCES—5, 6, 43, 74.

ENGRAVERS
Ips spp.

HOST—Sitka and white spruce.

DAMAGE—Cause mortality in saplings, pole-sized, and tops of mature trees.

DISTRIBUTION—Throughout Alaska, but more prevalent in the interior. A 1973 *Ips* buildup reached a 900 km expanse and then died down in the following years in the Yukon-Porcupine area.

DESCRIPTION—Adults are small, (0.3-0.6 cm long) cylindrical, reddish brown, black beetles. The head is not visible when the insect is viewed from above. A distinguishing feature of all *Ips* is a pronounced declivity on the posterior end which is margined with three to six pairs of tooth-like spines.

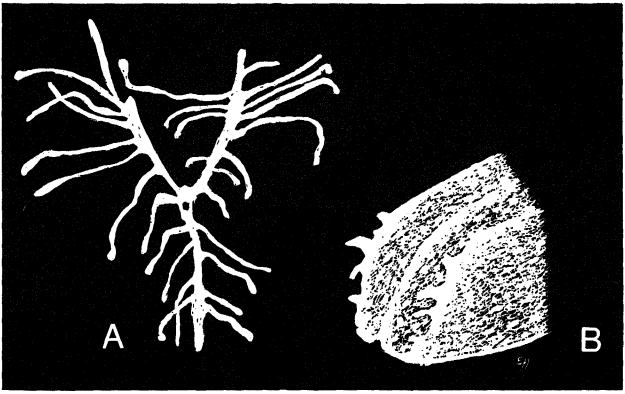


Figure 50—A. Engraver galleries; B. Characteristic pronounced declivity on the posterior end.

Larvae are segmented, soft-bodied, whitish, elongate cylindrical, legless grubs. Head color is tan, and the thoracic segment is enlarged. Eggs are fragile, globular to ovoid in shape and translucently white. They are located in niches or grooves along the sides of egg galleries.

BIOLOGY—There are a number of engraver species in Alaska. Most are similar in size, coloration, and habits. Therefore engravers are treated as a group. A listing of the more important *Ips* species will follow this discussion.

The first evidence of *Ips* attack is fine, yellow-red boring dust in bark crevices. Pitch-tubes are rarely formed. Adults disperse to new host material during mid-May. Preferred host material includes freshly cut logs, and tops of weakened trees. Dispersal is completed by the first week of June.

Ips are polygamous in contrast to the monogamous *Dendroctonus*. Male *Ips* begin tree attacks and males and females are soon attracted via pheromones. *Ips* aggregate on selected trees in response to male produced pheromones in the initial galleries. Two or more aggregating pheromones have been identified for *Ips;* these pheromones along with host volatiles direct aggregation. Engravers prefer sunnier and drier host material than do spruce beetles.

After boring into the bark, males construct an enlarged chamber called a nuptial chamber in the inner bark adjacent to the entrance hole. Adults construct egg galleries which radiate from the nuptial chambers. These egg galleries are kept clear of frass and boring dust. Larvae bore outwards from the egg galleries.

Preventive measures are the best suppression measures for *Ips* buildup. By preventing slash accumulation or by burning infested *Ips* material or scattering slash in **very** sunny locations helps reduce engraver buildup. Direct control operations generally are not used against *Ips* as outbreaks develop and disappear rapidly.

The following is a list of Alaska *Ips* species and their hosts:

1. *Ips pertubatus* (Eichh.)—White spruce
2. *I. concinnus* (Mann.)—Sitka spruce
3. *I. borealis* (Swaine)—White spruce
4. *I. tridens* (Mann.)—Sitka and white spruce
   = *(I. amiskwiensis* and *I. semirostris)*
5. *I. pini* (Say)—White spruce

REFERENCES—1, 10, 15, 27, 28, 29, 32, 34, 44.

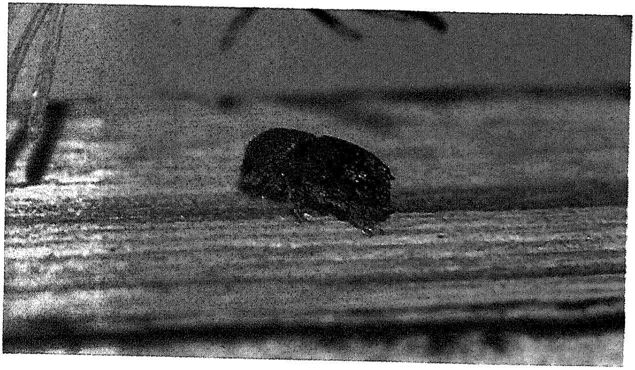


Figure 51—Adult engraver, *Ips* spp.

Figure 52—Characteristic boring material of the spruce engraver, *Ips* spp.

HEMLOCK HYLESINUS
Pseudohylesinus tsugae (Swaine)

HOST—Western hemlock.

DAMAGE—Larval galleries reduce host tree vigor.

DISTRIBUTION—Southeast Alaska.

DESCRIPTION—Adult beetles are stout, oval bark beetles approximately 3 mm long and reddish brown.

BIOLOGY—Adults construct short egg galleries at right angles to the wood grain. Larvae burrow parallel to the grain. The hemlock hylesinus breeds in felled or weakened western hemlock and can sometimes kill apparently healthy trees.

REFERENCES—27, 34, 44.

CEDAR BARK BEETLE
Phloeosinus squamosus (Blkm.)(= *P. sequoiae* Hop.)

HOST—Western red cedar and Alaska yellow cedar.

DAMAGE—Adult feeding causes twig and branch dieback. In some cases, weakened hosts are killed.

DISTRIBUTION—Southeast Alaska.

DESCRIPTION—Adults are oval beetles approximately 1.5-4 mm long. The head is visible from above; antenna clubs are conical, and the eyes are deeply notched.

BIOLOGY—Newly emerged adults fly to twigs of healthy trees where they construct feeding galleries in the phloem. This maturation feeding is normally the most destructive activity of *Phloeosinus.* The injured twigs and branches then break or die. The adults then disperse to weakened host material for breeding purposes.

Adults work in pairs when constructing brood galleries. Typical egg galleries consist of one short longitudinal gallery

originating from an enlarged entrance chamber and the galleries are kept clear of frass. Eggs are placed uniformly along the sides of the egg gallery. Larvae mine laterally in a regular pattern.

REFERENCES—1, 22, 24, 35, 44.

FOUR-EYED BARK BEETLE
Polygraphus spp.

HOST—Sitka, white, and black spruce, and lodgepole pine.

DAMAGE—Larval galleries found under the bark of dead or weakened host material. The four-eyed bark beetles are not of economic importance as forest pests in Alaska. However, they are frequently encountered in the field.

DISTRIBUTION—Throughout Alaska.

DESCRIPTION—Adult beetles are stout, cylindrical, reddish brown, and approximately 4 mm long.

BIOLOGY—Adults actively disperse in search of host material (downed logs or dead trees) from June to early July. *Polygraphus* flies whenever temperatures exceed 16 °C (60 °F), regardless of time of day. The female selects the host; mating takes place in a nuptial chamber in the inner bark. Females then excavate egg galleries and lay approximately twenty eggs. Egg galleries are not kept clear of frass. Females then emerge and initiate other egg galleries elsewhere in the same tree or a different host.

Cold temperature limits the beetle to one generation per year. *Polygraphus* has a rare trait among bark beetles; breeding adults overwinter and resume breeding the following spring.

REFERENCES—10, 22, 28, 29.

DAMAGE—Larval galleries found under the bark of dead and weakened host material.

DISTRIBUTION—Throughout Alaska.

DESCRIPTION—Adults are less than 4mm long and blackish.

BIOLOGY—Unknown in Alaska. Biological information from Canada and the contiguous United States indicate that beetles disperse to new host material during July. Egg galleries are irregular in shape. Larval galleries twist and cross frequently showing little orientation with respect to the wood grain. There is one generation per year.

REFERENCES—10, 15, 44.

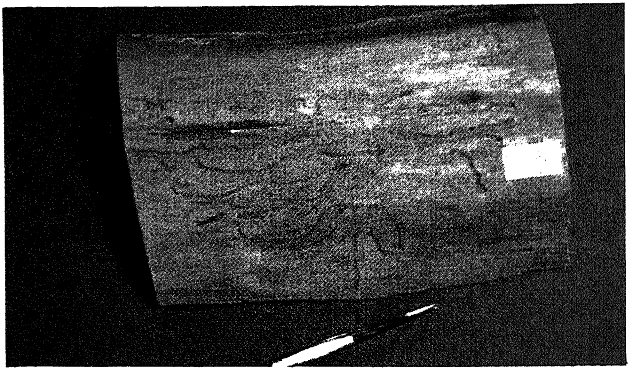


Figure 53—Gallery pattern of the cedar bark beetle, *Phloeosinus squamosus.*

Figure 54—Adult *Dryocoetes* spp.

Wood Borers

This group consists of several families which bore into the sapwood and, at times, the heartwood of weakened, recently felled or dead hardwood and conifer trees. Included here are the long-horned beetles or round-headed borers (Cerambycidae), the flat-headed borers (Buprestidae), the horntails (Siricidae), the ambrosia beetles (Scolytidae) and the marine borers. Most of these borers normally attack only freshly cut, injured, dying, or recently dead hosts. However, under certain circumstances, they can cause substantial economic losses in the form of wood degrade and volume loss.

Identification Key

1. Damage occurs only to wood exposed in salt or brackish waters ________ Marine Borers *Bankia* spp.

1'. Terrestrial Wood Borers ________ 2

2. Galleries less than .4 cm in diameter, penetrating the sapwood. ________ Ambrosia Beetles *Trypodendron*

2'. Galleries greater than .4 cm in diameter, scouring, and at times, penetrating the sapwood. ________ 3

3. Galleries up to .6 cm in diameter, circular in shape and packed with fine to granular frass. Larvae with a pointed, hardened, black spine extending backward from the last abdominal segment ________ Horntails *Urocerus*

3'. Galleries are oval in shape ________ 4

4. Boring characteristically fine and tightly packed in the galleries; larval thorax is flattened and distinctly broader than the abdominal segments; galleries oval in shape. ________ Flathead Borers

4'. Larval borings granular or splintery. Larvae are cylindrical in shape ________ Roundhead Borers

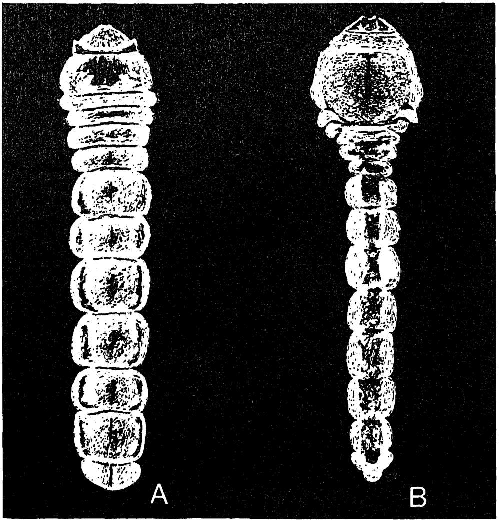


Figure 55—Wood borer larvae: A. Round-headed borer (Cerambycidae); B. Flatheaded borer (Buprestidae).

Roundhead Borers or Longhorned Beetles (Coleoptera: Cerambycidae)

The larvae of this group of insects live as borers in the tissues of trees and other woody plants and are at times serious pests. Smaller trees are sometimes girdled and killed. The sapwood and heartwood of larger trees are riddled and weakened and become susceptible to wind breakage or death. The round-headed borers reduce both grade and volume in logs and pulpwood and also introduce stain-causing fungi which degrade lumber values. Adults may emerge from bark beetle-killed timber used as house logs after the log house has been constructed.

Those round-headed borers which require moist, dead wood are generally beneficial. They are considered the most prominent insects involved with decomposition of slash, stumps, and dead and dying trees in north temperate forests.

Cerambycid larvae are characterized by a whitish-elongate-robust to slender body. They are soft, fleshy, and cylindrical to somewhat flattened in shape, with the head slightly flattened. Adult beetles are cylindrical, oblong-elongate to somewhat flattened; sometimes brightly colored. The antennae are long and slender, usually 11-segmented, and as long or longer than the body. Some species make squeaking noises when disturbed, and the larvae of the "sawyers" produce a loud noise while boring.

WHITESPOTTED SAWYER
Monochamus scutellatus (Say)

HOST—Western hemlock, black and white spruce.

DAMAGE—The larvae bore into dead or dying trees and often introduce wood rotting fungi. Adults sometimes feed on the bark of branches.

DISTRIBUTION—Throughout Alaska.

DESCRIPTION—Full grown larvae are approximately 50 mm long, whitish, elongate and cylindrical with soft, legless body, and dark brown mandibles. The head is slightly flattened. Adults are stout, dull black beetles, 2.5 cm long with grey-white markings on wing covers; antennae twice as long as body; toothlike projections on sides of prothorax.

BIOLOGY—Adults emerge in early July to mid-August and deposit eggs under the bark scales of dying trees. Newly developed larvae feed in the cambium and heavily scour the sapwood surface. Coarse, splintery larval frass, characteristic of cerambycids, is usually present on or in infested material. Larvae tunnel into and overwinter in the sapwood. The second year is spent in the larval stage with pupation and adult emergence occurring the following spring.

REFERENCES—22, 27, 29, 34.

Xylotrechus undulatus (Say)

HOST—White spruce.

DAMAGE—Attacks injured or recently killed trees.

DISTRIBUTION—Interior Alaska.

DESCRIPTION—Adults are stout and cylindrical from 12-19 mm long with antennae only slightly longer than combined length of head and thorax. Wing covers are black and sharply outlined with white crescent shaped markings.

BIOLOGY—Unknown in Alaska.

REFERENCES—27, 29.

OTHER ALASKA CERAMBYCIDAE

Acmaeops p. proteus (Kby.)
Acmaeops pratensis Laich.
Arhopalus productus (LeC.)

Elaphidion sp.

Pachyta lamed (LeC.)
Gnathacmaeops pratensis (Laich.)
Neoclytus m. muricatulus (Kby.)
Callidium cicatricosum Mann.
Pronocera c. collaris (Kby.)

Tetropium velutinum Lec.

Phymatodes dimidiatus (Kby.)
Pogonocherus mixtus Hald.
Pogonocherus penicillatus LeC.
Meacanthocinus pusillus (Kby)

Grammoptera subargentata (Kby.)

Judolia m. montivagans (Cooper)
Tetropium cinnamopterum parvulum (Csy.)

HOST—White and black spruce.

DISTRIBUTION—Interior Alaska.

DESCRIPTIONS AND BIOLOGIES—Unknown in Alaska.

REFERENCES—28, 29, 71.

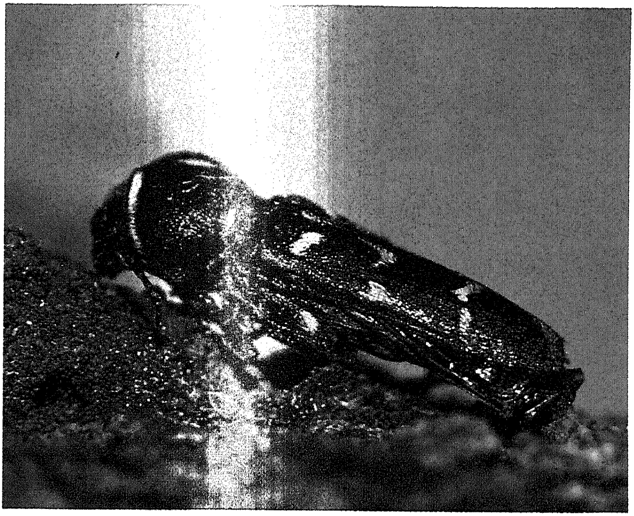


Figure 56—Adult *Xylotrechus undulatus.*

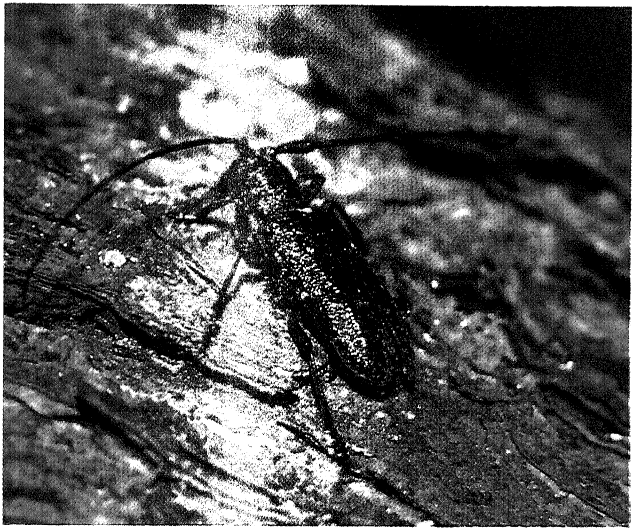


Figure 57—White spotted sawyer, *Monochamus scutellatus.*

Metallic or Flat-Headed Wood Borers (Coleoptera: Buprestidae)

Unlike the cerambycids, the buprestids almost never develop in decayed wood; they are restricted to recently weakened or killed material. The buprestids are destructive in that they sometimes kill living trees and often reduce the value of lumber through their attacks. The winding larval galleries, present in the sapwood and heartwood, are characteristically tightly packed with boring material.

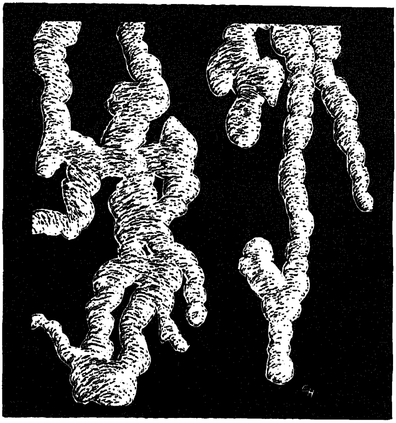


Figure 58—Galleries of flatheaded fir borers characteristically packed with boring material.

Adults are flattened, frequently brightly colored, iridescent beetles with short antennae. Females oviposit in bark crevices, and developing larvae construct long, winding, oval galleries in the bark and/or the wood. Adults of many species can successfully attack and develop in pitchy fire scars on living trees and in trees weakened by root decay, or in unseasoned lumber, milled wood, wood placed in storage, and wood in use. Buprestid larvae are easily recognized by a greatly expanded head and thorax and a long, slender abdomen.

The prevention of fire scars and other injuries to standing trees and the prompt utilization of diseased and felled trees can greatly reduce buprestid damage.

FLAT-HEADED FIR BORER
Melanophila drummondi (Kby.)

HOST—Western hemlock.

DAMAGE—Attacks damaged or weakened trees.

DISTRIBUTION—This borer has caused severe, but localized, damage on western hemlock in southeast Alaska. In the late 1960's, periodic flooding of western hemlock stands on the Salmon River near Hyder brought about a general decline in stand health. Samples taken at DBH (1.3 m from ground) contained as many as twelve larvae per 90 cm^2 of bark surface. Salvage logging was employed as a suppression measure.

DESCRIPTION—Adults are approximately 1.3 cm long and are metallic bronze or black with an iridescent sheen. Larvae are creamy white grubs with thorax and head greatly expanded and abdomen long and slender. Buprestid galleries differ from those of round-headed borers by being packed tightly with fine, dark excrement and wood particles.

BIOLOGY—Little is known concerning the biology of this insect. Investigations into the host selection behavior of *M. drummondi* have demonstrated that adults are attracted to acetone and to a variety of substances associated with conifers including terpenes, scolytid pheromones and ethanol. *M. drummondi* overwinters in the larval stage within the host bark.

REFERENCES—18, 34, 57.

BRONZE BIRCH BORER
Agrilus anxius Gory

HOST—Aspen and paper birch.

DAMAGE—Attacks confined to individual ornamental trees, trees in open stands or exposed branches in fully stocked and stagnating stands; repeated attacks can reduce host tree vigor until death.

DISTRIBUTION—Interior Alaska.

DESCRIPTION—Adults are olivaceous brown-black, approximately 1.3 cm long. Larval galleries are winding, about 6 mm wide and always tightly packed with boring dust.

BIOLOGY—Adults emerge in late spring and summer and select sunny portions of trees for egg laying. Eggs are deposited on the bark surface of branches and upper parts of trees, especially those on poor sites. Larvae leave the phloem region at intervals and dip into the sapwood to molt. Larvae pupate in the host bark in autumn. Adults may feed, upon emergence, on host foliage.

There is only one generation per year in overmature, slow growing trees.

CONTROL—Silvicultural measures are the most practical to suppress *A anxius* infestations. The best way to avoid attack is to maintain stands as healthy as possible. If birch regeneration is considered, only good sites should be utilized. Care should be taken not to leave host material directly exposed to the sun as *A. anxius* prefers sunny locations for oviposition sites. To avoid vulnerability to exposure, stands should be clearcut or by cutting in groups, maintaining adequate shading for the remaining trees.

REFERENCES—1, 32, 43, 65.

OTHER ALASKA BUPRESTIDAE
Melanophila fulvoguttata (Harris)
Chrysobothris trinervia (Kby.)
Buprestis nutalli (Kby.)

HOST—White spruce.

DISTRIBUTION—Interior Alaska.

DESCRIPTION AND BIOLOGY—Unknown in Alaska.

REFERENCES—29, 71.

Figure 59—Adult flatheaded fir borer, *Melanophila drummondi.*

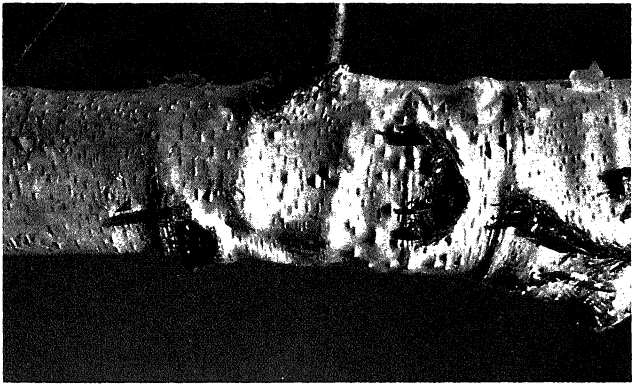


Figure 60—Stem swellings, an indication of bronze birch borer activity, *Agrilius anxius.*

Figure 61—Bronze birch borer galleris, *A. anxius.*

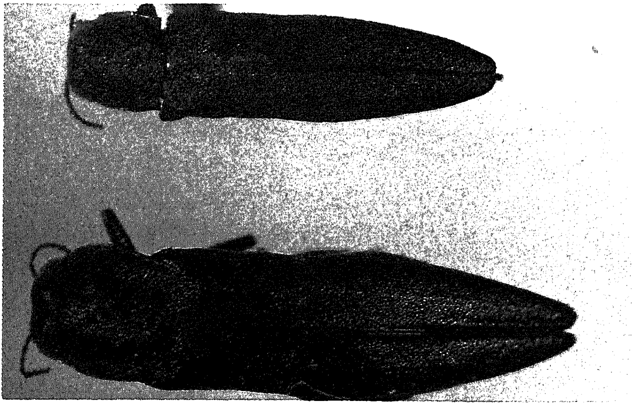


Figure 62—Adult bronze birch borer, *A. anxius*.

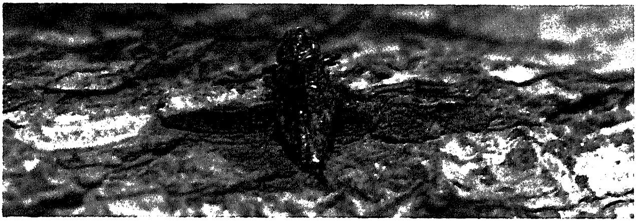


Figure 63—Flatheaded spruce borer, *Chrysobothris trinervia*.

Ambrosia Beetles (Coleoptera: Scolytidae)

Ambrosia beetles are important pests of forest products because they riddle the sapwood and heartwood of unseasoned logs and poles. The entrance holes and small larval galleries are inoculated with dark brown or black stain fungi. Ambrosia beetles do not feed directly on the host tree, but obtain nutrients that have already been processed by the introduced fungi. Each ambrosia beetle species has a close symbiotic relation with a specific wood staining fungus. The beetles have specialized structures, mycangia, used for transporting the fungus from one host to another.

The living requirements are very exacting for ambrosia beetles; unseasoned wood is suitable for attack whereas dried seasoned lumber is immune to attack. Damage is usually greatest where mild winters allow favorable temperatures and moisture conditions for extended periods of beetle activity.

Suppression of ambrosia beetles is a matter of prevention. Logs which are cut in the summer or fall should be removed from the woods as quickly as possible and either placed in fresh water or processed at the mill. Prompt use of timber is about the only satisfactory solution for preventing ambrosia beetle damage.

AMBROSIA BEETLE
Trypodendron lineatum (Oliver)
T. betulae Swaine

HOST—Western hemlock, Sitka and white spruce, and birch.

DAMAGE—Sapwood and heartwood of unseasoned logs and poles are riddled with larval galleries. Symbiotic fungi produce a brown to black stain in and around the larval galleries. Fortunately, most of the damage is confined to the sapwood, but galleries may extend into the heartwood. Ambrosia beetle damage cannot be eliminated economically because populations breed in stumps, fallen trees, and trees whose tops are broken from ice and snow.

DISTRIBUTION—Southeast, south-central, and interior Alaska.

DESCRIPTION—Adults are small, stubby, dark beetles with a smooth, shiny body often with lighter colored longitudinal stripes.

BIOLOGY—*T. lineatum* adults overwinter in the litter on the forest floor. In the spring females select host material and initiate boring. Additional attacks are promoted by an aggregating pheromone. Galleries penetrate directly into the wood a short distance before branching into one of three egg galleries where adults then lay eggs. After the eggs hatch, the larvae enlarge these niches into larval cradles,

and feed on ambrosia fungi introduced by the parent adults. In late summer, the brood matures, and adults emerge and disperse to hibernation sites. The biology of *T. betulae* has not been investigated.

REFERENCES—15, 16, 22, 29, 34, 35.

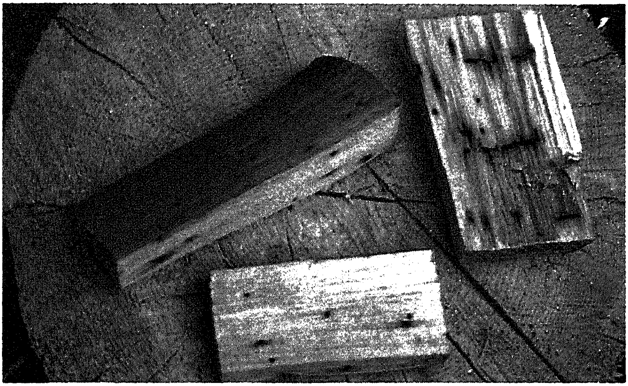


Figure 64—Entrance holes and galleries of the ambrosia beetle, *Trypodendron betulae,* and black stain produced by symbiotic fungi.

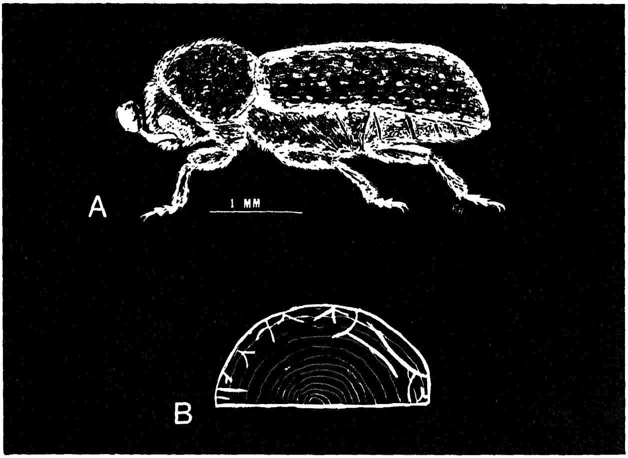


Figure 65—Ambrosia beetle, *Trypodendron* spp.: A. Adult; B. Position of galleries.

Wood Wasp (Hymenoptera: Siricidae)

Wood boring wasps or horntails are responsible for more damage than is usually ascribed to them. Wood wasps are especially abundant and injurious in fire killed forests. Trees killed by spring fires are more susceptible to attack. These borers may continue to work in sawed lumber taken from infested logs. Kiln drying usually kills larvae in sawed material. Fresh water treatment of sawlogs and prompt utilization of are the best ways to prevent injury.

HORNTAIL
Urocerus gigas flavicornis F.

HOST—White spruce.

DAMAGE—Attacks weakened trees and produces round galleries in cross section in the wood.

DISTRIBUTION—South-central and interior Alaska.

DESCRIPTION—The adult is a menacing looking, thick-bodied black and yellow wasp. The female bears a hornlike ovipositor sheath projecting beyond the abdomen. The female inserts her ovipositor through the bark and deposits from one to three eggs. The larvae are white, legless grubs, cylindrical in form with a dark spine on the end of the abdomen.

BIOLOGY—Larvae construct round galleries in cross section which penetrate into the wood. The galleries increase in size as the larvae enlarge. Horntail larvae consume wood which passes through their digestive tract and is packed tightly behind them. As with most siricid species, the larvae require from one to two seasons to complete development. The larvae construct pupal chambers in the outside layers of the sapwood. Pupal chambers are usually constructed on the shade side of logs.

REFERENCES—27, 29, 44.

Figure 66—Wood wasp (horntail) ovipositing in white spruce, *Urocerus g. flavicornis*.

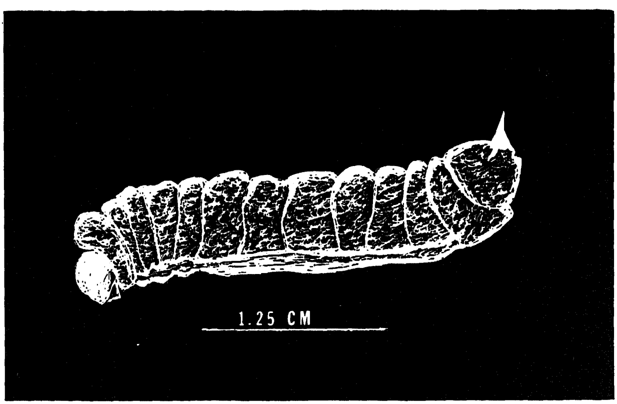


Figure 67—Horntail larva.

Marine Borers or Shipworms (Mollusca)

Shipworms are bivalved mollusks, not insects, but their damage is frequently mistaken for insect damage. Marine borers are especially damaging to pilings, although they will attack almost any kind of wood submerged in salt water. More than one half the volume of pilings may be destroyed with little external evidence of damage. Usually logs with the bark intact are resistant to attack, but exposed wood is especially subject to attack.

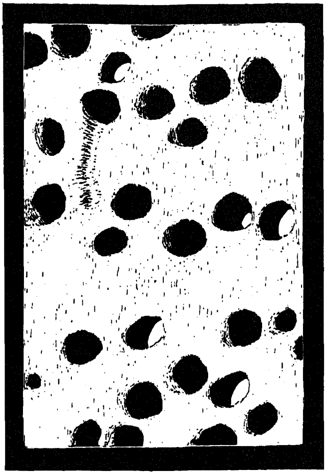


Figure 68—Marine borer damage.

SHIPWORMS

Bankia setacea (Tyron)

HOST—Untreated rafted logs and pilings.

DAMAGE—Galleries penetrate sapwood and heartwood.

DISTRIBUTION—Southeast Alaska.

DESCRIPTION—The shipworm, in its burrow, is elongate and soft-bodied. The anterior end of the body has a small chisel-like shell and the posterior end bears two tubes that are exhalant and inhalant siphons. Some of the larger species may obtain a length of 0.5 m or more.

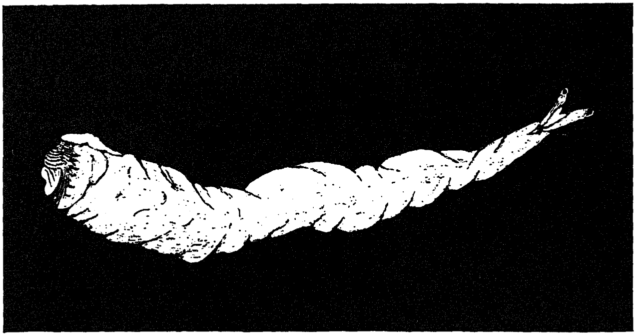


Figure 69—Adult marine borer.

BIOLOGY—The early life of marine borers is spent as tiny free swimming organisms provided with a bivalve shell. They grow and enlarge their galleries rapidly inside the wood. Galleries are lined with a secreted calcareous material. The young grow rapidly; some are as long as 45 cm after eight months.

B. setacea can be destructive to rafted logs and untreated pilings in southeast Alaska. They are especially destructive in booming grounds and log storage areas. Marine borer populations build up in sunken logs and then attack fresh logs. Shipworm damage can be reduced or eliminated by removing sunken logs, storing logs on land, or storing logs in fresh water which kills shipworms. Log storage at river mouths provides limited protection.

REFERENCES—32, 35.

Cone and seed insects are relatively unimportant economically in a natural forest. The amount of seed produced by forest trees under natural conditions usually far exceeds the number of seeds destroyed by these insects. When good seed years occur in succession, cone and seed insects may build up to exceptionally high numbers. Consequently, the crop produced the second year may be almost completely destroyed (32, 44). In some seasons, insects and red squirrels may destroy all the spruce seed in certain localities.

Destruction of forest seeds may be caused by insects which feed on buds, flowers, or immature cones, as well as by insects that actually destroy seeds. In many cases, the cones show no outward sign of injury, but the seeds may be infested. Many of the insects (budworms) that feed upon buds and green tips also attack immature cones indirectly. The most injurious groups of cone and seed insects in Alaska are the seed moths (Lepidoptera), cone beetles (Coleoptera), seed worms and midges (Diptera), and bugs (Hemiptera). In Alaska, the true bugs feed exclusively on birch, alder, and aspen seeds. The other species feed on spruce and hemlock cones and seeds.

To date, few seed and cone insects have been associated with Alaska conifers, particularly in southeast and south-central Alaska (71) although *Laspeyresia youngana* (Kft.) is known to attack Sitka spruce cones heavily during good cone crop years.

Six species of insects injurious to white spruce cones and seeds near Fairbanks were identified: Spruce seed moth, *Laspeyresia youngana* (Kft.); Spruce seed chalcid, *Megastigmus piceae* Felt; Spruce cone-axis midge, *Dasineura rachiphaga* Tripp; Gall midge, *Phytophaga carpophaga* Tripp; and cone maggots, *Pegohylemia* spp.

SPRUCE SEED MOTH
LEPIDOPTERA: OLETHREUTIDAE
Laspeyresia youngana (Kft.)

HOST—Sitka and white spruce, western hemlock.

DAMAGE—Larvae bore into the cone scales and feed from seed to seed.

DISTRIBUTION—Distributed throughout Alaska. Damage to Sitka spruce cones was recorded in 1956 from Homer, Seward, and Cordova. The causal agent was identified as *L.youngana;* the overall effect on the seed crop was not determined. Sitka spruce cones in southeast Alaska were found damaged by *L. youngana* in 1966. Sitka spruce seed damaged by the spruce cone moth was collected from Afognak Island in the fall of 1973. Out of a 565 seed sample, 32.6 percent was insect damaged.

DESCRIPTION—Adult insects are small, inconspicuous moths. Last instars when full grown, are about 1.4 cm long.

BIOLOGY—Adults emerge from infested cones from May to June and oviposit on young cones..The eggs hatch about mid-June and each young larva crawls to the base of a cone scale to enter a seed. The larvae pass through four instars, feeding from seed to seed. Frass is packed in the tip of the gallery and in the mined seed. Usually only one larva reaches maturity in a single cone. An exit hole is made near the base of the cone, attended by a short, silk tube leading to the outside between the cone scales. This tube, which is made just before pupation in the fall, is diagnostic for this insect and is the only evidence of cone attack. The last instar overwinters in the cone. Pupation occurs the following May. There is usually one generation per year, but generations may overlap.

REFERENCES—5, 39, 40, 73.

SPRUCE CONE-AXIS AND GALL MIDGES
DIPTERA: CECIDOMYIIDAE
Dasyneura rachiphaga Tripp *D. canadensis* Felt

HOST—White spruce.

DAMAGE—Larvae burrow in and around the cone-axis and indirectly damage the seed.

DISTRIBUTION—South-central and interior Alaska.

DESCRIPTION—Adults are small, dark midges approximately 3mm long. The mature larva is yellow.

BIOLOGY—Little information concerning these species has been collected in Alaska. In British Columia, *D. rachiphaga* is probably the most abundant insect in white spruce cones. The larvae burrow in and around the cone-axis. Since the larvae do not feed on or adjacent to the seeds, they do not damage them directly. *D. canadensis* is usually secondary in importance. Each larva creates a small gall in cone scales. This species causes little, if any, damage to spruce seed.

REFERENCES—39, 66.

SPRUCE CONE MAGGOT
DIPTERA: MUSCIDAE
Pegohylemia spp.

HOST—Mountain hemlock, Sitka, white and black spruce.

DAMAGE—Larvae consume seed.

DISTRIBUTION—Throughout Alaska.

DESCRIPTION—Adult flies are shiny black and approximately 6 mm long. The larvae (maggots) are white, about 8 mm long, having two large, black hooks on the head.

BIOLOGY—The following biology is from British Columbia; it is unknown in Alaska. Adult cone maggots emerge from pupal overwintering sites in forest litter. Eggs are deposited between cone scales and the maggots tunnel about the

seed. After three weeks of feeding, the larvae emerge from the cone and drop to the ground where they overwinter as pupae.

There is very little evidence of injury on infested cones. Usually one maggot completes development in each infested cone and may destroy up to 50 percent of the seed.

REFERENCES—40, 44, 66.

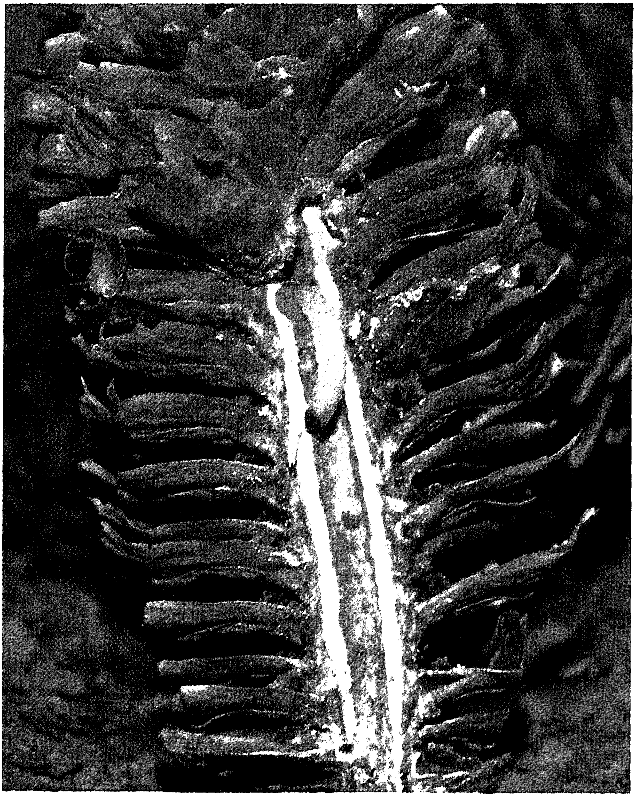


Figure 70—Last instar of the spruce seed moth, *Laspeyresia youngana*, feeding within a Sitka spruce cone.

To date, there have been few problems with insect pests of wood products in Alaska. In the southern latitudes wood products insects cause tremendous losses. It has been estimated that the loss from these insects is about 1-5 percent of the annual cut. However, climatic conditions effectively bar many of these wood destroyers from the more northerly latitudes. Only 13 species of insects have been associated with wood products in Alaska (71), and few have caused some structural damage to wooden buildings. Some (woodborers) have previously been discussed, others are described below.

Insects of wood products either attack **moist,** seasoned wood or attack **dry,** seasoned wood (32). Those insects that attack moist, seasoned wood are usually symbiotically associated with protozoa, fungi, and bacteria which aid the insects in the digestion of cellulose and lignin.

Some of these insects do not obtain their food from the wood. They tunnel into the wood to secure a sheltered base for foraging expeditions and a nursery for the young. Those insects attacking dry, seasoned wood also live in a symbiotic relationship with other micro-organisms. These insects can breed successfully in wood with a water content as low as six percent.

The suppression of insects injurious to forest products is largely a matter of damage prevention. Kiln dried lumber is more or less resistant to insect attack, but a few species attack kiln dried material.

CARPENTER ANTS
HYMENOPTERA: FORMICIDAE
Camponotus herculeanus Whl.

HOST—White spruce, birch.

DAMAGE—In the northern temperate zones, carpenter ants can cause extensive structural damage to buildings. These ants build their nests in several types of wood. They attack moist heartwood of living trees, or they hollow out logs,

house timbers, or other soft, wood materials that are wet or moist. In Alaska, *C. herculeanus* has damaged standing white spruce, birch, and house logs. Carpenter ants tunnel into wood for shelter and brood raising, but do not eat the wood. They forage from these shelters and consume both animal and vegetable material.

DISTRIBUTION—Throughout Alaska.

DESCRIPTION—Ants have elbowed antennae, large heads with constrictions between the thorax and head, and the thorax and abdomen. When wings are present, they are translucent with prominent venation. The adult carpenter ant is shiny black and large. There are three labor castes: (1) the queens, 15-20 mm long; (2) the kings, 10 mm long; and (3) the workers, 6-10 mm long, which are sexually imperfect females. Only the queens and kings have wings. The egg is elongate, translucent white, and gourd-shaped. The pupae are creamy-white in papery, light brown cocoons.

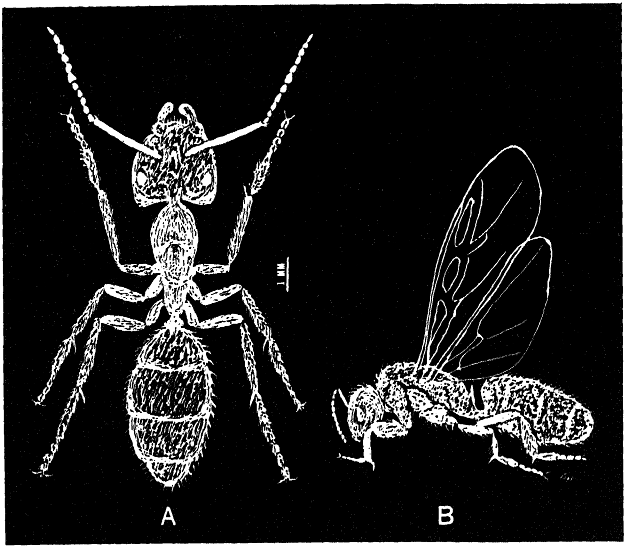


Figure 71—Carpenter ant: A. Worker; B. King.

BIOLOGY—Males and females swarm and mate in May and June. After this mating flight, females either reestablish an old colony or establish a new nest. The young queen seeks out a small cavity in a tree or timber. She seals herself in, deposits her eggs, and does not feed until her first brood is mature. The young workers feed the queen and cut parallel, concentric galleries in a vertical direction throughout the wood.

The presence of carpenter ants can be detected by piles of "sawdust" at the base of posts, along sills, or elsewhere. Unused nest openings are sometimes sealed with plugs of wood. Carpenter ants do their greatest economic injury to houses where wood timbers are in contact with the ground.

Prevention is the best control. **Moist** wood is attractive; so measures to prevent wood in structures from becoming wet are very important. Building sites and adjacent areas should be cleared of stumps and partially decomposed logs. Buildings should be placed on concrete or masonary foundations or on treated timbers. This will greatly reduce attack by carpenter ants. Lumber and debris in basements is attractive to carpenter ants and may provide nesting sites.

Badly damaged timbers may need replacement. Suppression measures may need to be taken if ants are foraging within a house, or other structure.

REFERENCES—32, 51, 71.

Figure 72—Carpenter ant worker, *C. herculeanus*.

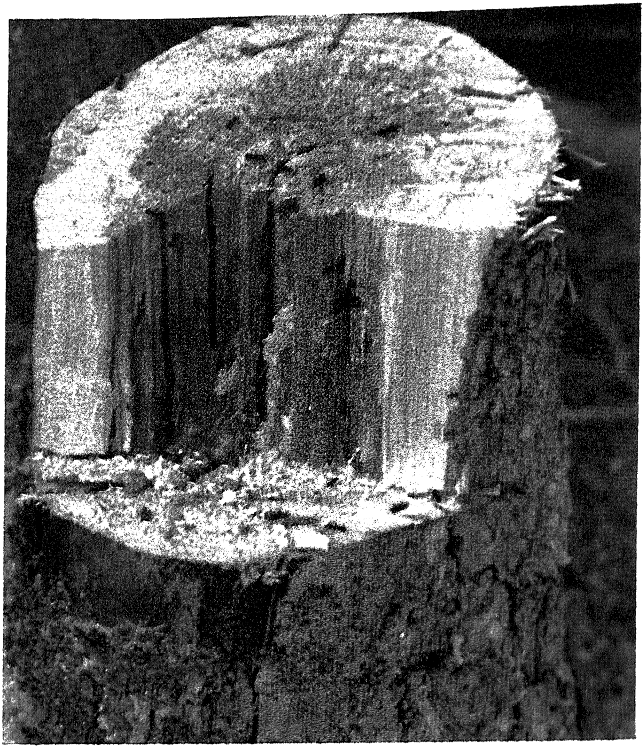


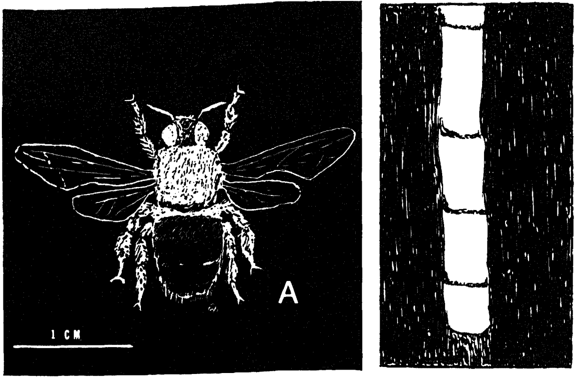
Figure 73—Carpenter ant damage, *Camponotus herculeanus*.

CARPENTER BEES
HYMENOPTERA: XYLOCOPIDAE
Xylocopa spp.

HOST—White and black spruce.

DAMAGE—Carpenter bees, like the carpenter ants, cause structural weakening in house timbers where their galleries are concentrated. Carpenter bees have been reported to attack and burrow into wood houses and other wood structures in Alaska. Often, carpenter bees merely take over the galleries of other wood-boring insects.

DISTRIBUTION—South-central and interior Alaska



B

Figure 74-Carpenter bee, *Xylocopa* spp.: A. Adult; B. Chambered galleries.

DESCRIPTION—Carpenter bee adults are 1.5-2.5 cm long, robust, and resemble bumblebees. The upper surface of the abdomen of carpenter bees is largely bare; whereas, bumblebee abdomens are covered with hair. Females are greenish-black; males are often yellow with pale hairs. Larvae are typical hymenopteran grubs; legless, head globular with small mouthparts, and thoracic segments smaller than those of the abdomen. Pupae are robust, pale, and always found inside silken, leathery cocoons.

BIOLOGY—Adults emerge in the spring, and after mating, the females disperse and burrow into wood which is not eaten, but discarded. Eggs are deposited and larvae are fed pollen and nectar collected by the adults. Tunnels penetrate inwards for a few centimeters or so, and then turn and parallel wth the wood grain. Galleries are divided into individual cells, about 2 cm long, by means of cross walls which consist of cemented, compacted, chewed wood. There is one larva per cell. New adults escape through entrance holes constructed by parents. There is usually one generation per year.

Controls are seldom needed, but coating the wood with varnish or paint is effective in preventing attacks.

REFERENCES—1, 71.

POWDER POST BEETLES
COLEOPTERA: LYCTIDAE
Lyctus spp.

HOST—Sapwood of seasoned hardwoods with a moisture content between 6 and 30 percent.

DAMAGE—*Lyctus* are the most injurious of the powder post beetles in North America. Severely infested wood is reduced nearly to powder, but remains somewhat covered by nearly intact but, holey, exterior shell. Furniture and hardwood lumber dealers often discover these pests. Axe and shovel handles may be destroyed, and infested hardwood flooring may be installed without knowledge of the beetles' presence. When adults emerge, the wood exhibits numerous small, round exit holes. In Alaska, museum displays of wooden snowshoes, etc., have been infested by powder post beetles.

DISTRIBUTION—Throughout Alaska.

DESCRIPTION—Beetles are 0.6 cm long, with a flattened, elongated body, and are brown to black. Larvae are small, whitish, cylindrical grubs with three-segmented pairs of thoracic legs.

BIOLOGY—Mated females deposit eggs in wood pores approximately 0.3 cm deep, and new larvae bore through the wood in all directions. Overwintering larvae pupate at the end of larval galleries. Adults emerge through round, 0.2 cm exit holes. There is usually one generation per year, but two years or more may be required to complete development under unfavorable conditions.

Preventive measures are the best control. Protecting susceptible wood by painting with linseed oil, varnish, or paint effectively prevents oviposition. Stored heartwood and sapwood lumber should be separated where possible, and inspected frequently. Infestations can be detected by the small quantities of fine boring dust on and in the vicinity of the infested material.

REFERENCES—1, 32, 71.

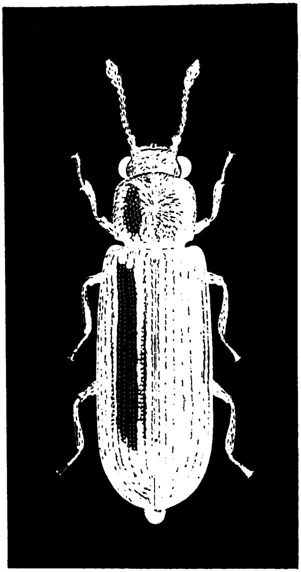


Figure 75—Adult powder post beetle, *Lyctus* spp.

Figure 76—Powder post beetle emergence holes in a shovel handle.

Abdomen—Posterior part of the insect's main body divisions

Adult—Full-grown, sexually mature insect; usually with wings in contrast to larvae which lack wings.

Arthropod—Largest phylum in the animal kingdom including insects, crabs, spiders, etc.

Boring-dust—Reddish-brown to tan, pulverized bark excavated by the adult bark beetle as it bores through the outer bark; often found in small piles in bark crevices and around base of tree.

Cambium—Layer of cells between xylem and bark, forms additional xylem and phloem elements.

Cornicle—Dorsal tubular processes on the posterior portion of the abdomen (Fig. 37).

Epidemic—Large scale temporary increase in an insect or disease population.

Fecundity—Ability to produce young.

Flag—Dying or recently dead branch contrasting in color with the normal green color of a living tree.

Frass—Solid insect excrement, usually in small pellets.

Galls—An abnormal growth of plant tissue, stimulated by insect or fungal activity.

Genus—A group of closely related species. Similar genera are grouped in a family.

Gregariously—Insects tending to feed or remain in groups.

Grub—Thick-bodied larva, usually sluggish, good fishing bait.

Heartwood—Central mass of tissue in tree trunks, with no living cells and no longer functioning in water conduction but only for mechanical support.

Honeydew—Sugary liquid excretion of aphids or scales.

Instar—The stage of an insect between successive molts.

Lanceolate—Spear-shaped, tapering at each end.

Larva—Immature form of an insect such as a caterpillar, grub, or maggot.

Mollusca—Large phylum of animals including clams, mussels, snails, etc., mostly aquatic; soft-bodied, often with a hard shell.

Molt—Process of shedding the exo-skeleton, the insect "skin".

Monogamous—Mating with only one individual.

Mycangia—Structure used for the transportation of symbiotic fungi from one host to another.

Necrotic—Death of the affected tissues.

Nuptial chamber—Mating site.

Nymph—Immature form of an insect resembling the adult except for incomplete wing development.

Oviposit—Lay or deposit eggs.

Ovipositor—Egg-laying apparatus.

Parthenogenetic—Reproducing by eggs that develop without being fertilized.

Pheromone—Chemicals which are produced by one individual to affect or alter the behavior of another individual of the same species.

Phloem—Vascular tissue that conducts synthesized foods through the plants, located adjacent to cambium, essentially the inner bark.

Pitch-Tubes—A tubular mass of cream colored resin mixed with bark, wood borings, and insect excrement that forms on the surface of the bark at beetle entrance holes.

Plumed—Feather-like.

Polygamous—Mating with several individuals.

Pronotum—The dorsal plate of the prothorax.

Prothorax—The anterior of the three thoracic segments.

Pupa—Inactive stage of an insect; transitional stage from larva to adult.

Radial Growth—One-half the diameter growth of a tree.

Sapwood—Outer region of xylem of tree trunks, containing living cells and functioning in water conduction, food storage and mechanical support.

Serrate—Saw-toothed edge.

Slash—Debris such as logs, bark, branches left after cutting timber.

Sub-cortical—Below the bark.

Symbiotic—An intimate association between two species which benefits both.

Terminal Growth—Height growth of a tree.

Terpenes—Unsaturated hydrocarbons occurring in plant oils and resins.

Thorax—The body region behind the head, which bears the legs and wings.

Windthrown—Trees up-rooted by wind.

Xylem—Vascular tissue that conducts water and mineral salts, taken in by roots, throughout the plant, essentially the woody part of the stem or trunk.

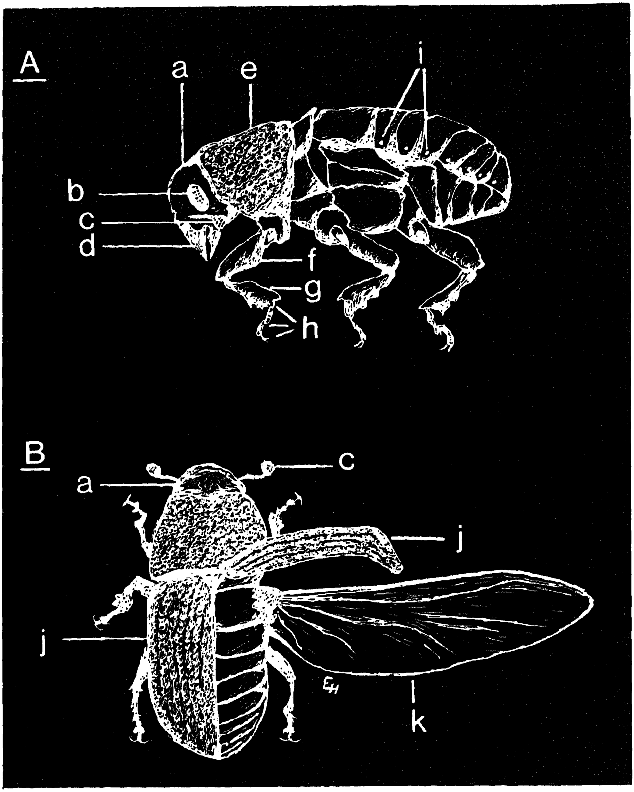


Figure 77—External insect morphology: A. Side view of a bark beetle with wings and wing covers removed; B. Dorsal view. **LEGEND:** a. Head, b. Compound eye, c. Antenna, d. Mouthparts, e. Pronotum, f. Femur, g. Tibia, h. Tarsus, i. Spiracles, j. Elytra (wing covers), and k. Membranous wings.

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Diseases

For the purpose of this handbook, forest or tree disease is defined as impairment, in whole or in part, of the health of trees caused by living organisms (other than insects) or by, chemical or physical (light, moisture, and atmospheric) factors.

Disease is an integral part of a forest ecosystem. In a normal situation, trees and their associated diseases have evolved together and co-exist in a more or less balanced manner.

Trees are susceptible to a sequence of different diseases at different stages of their growth. Early susceptibility thins a forest stand resulting in more vigorous crop trees. In turn, late susceptibility removes the older and more decadent trees making room and preparing the way for the new stand. However, the introduction of a forest pathogen not native to an area can lead to catastrophic disease outbreaks at any stage of growth. Examples are white pine blister rust and chestnut blight, the first having made the management of white pine uneconomical in some areas and the second having virtually eliminated American chestnut. Planting trees off site or under natural conditions (such as planting pure stands of a species that normally occur in mixed stands) introduce unusual conditions which tend to make the trees more susceptible to disease organisms or less resistant to climatic stresses.

In undisturbed forests, native diseases rarely become epiphytotic, the organisms are in biological balance with their hosts. An examination of a stand for disease can tell much more than just the volume loss due to disease. If the stand is overmature, this will be shown by the presence of many decay organisms and much cull. If the stand consists of an overstocking of reproduction, then one will probably find organisms such as *Sirococcus strobilinus*, which thrive in such conditions, thinning out the seedlings or saplings and essentially designating the crop trees (for better or worse). If an epiphytotic situation exists, then one will suspect either drastic changes in the environment, various kinds of management practices (possibly misapplied), or the introduction of non-native pathogens.

Tree disease descriptions in this handbook do not represent a complete compilation of all those present in Alaskan forests. Only the most common or those most frequently asked about are described. Only the most common or important hosts are listed for a pathogen. This handbook is intended as an aid in identifying the more common tree diseases. References are included.

Arceuthobium tsugense (Rosendhal) G. N. Jones — HEMLOCK DWARF MISTLETOE

HOSTS—Western hemlock, mountain hemlock, and rarely Sitka spruce.

DISTRIBUTION—Southeast Alaska, south of Haines.

PATHOGEN— A dioecious, seed-bearing plant averaging 5 to 13 centimeters in height, with vestigial leaves and an endophytic system which invades the cortex and xylem of the host. The fruit is an ovoid light green to olive green capsule containing a single seed which is explosively discharged when mature. Pollination occurs in late summer and seed maturation in the late fall or early winter of the next year. Infection occurs when a seed which is coated with a sticky water soluble substance becomes attached to a host's twig, germinates, and penetrates the tissues.

DAMAGE AND CONTROL—Weakening of the trees, making them more susceptible to other pathogens or insects, early mortality may occur. Height and diameter growth, and wood quality are adversely affected. Large witches brooms and cankers may be present on the limbs and burls and cankers on the stems of infected trees.

Control is accomplished by clear cutting, removal of infected trees, or by pruning infected branches. The method used depends on stand age, condition, value and the management objectives.

REFERENCE—6, 16, 21, 53, 55, 58, 62, 67, 75, 81, 82, 91, 103, 104, 105, 119, 120.

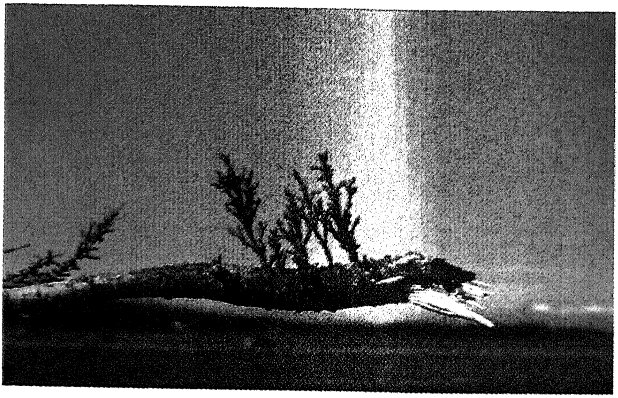

Figure 78—Hemlock dwarf mistletoe on western hemlock.

Figure 79—Witches brooms on western hemlock caused by dwarf mistletoe.

Cryptosphaeria populina (Pers.) Sacc. CRYPTOSPHAERIA CANKER

HOSTS—Aspen, balsam poplar, and cottonwood.

DISTRIBUTION—Interior Alaska.

PATHOGEN—This fungus attacks wounded trees of all ages. Entry is through bark wounds of live branches or stems. After infection occurs the fungus moves into the sapwood and then the heartwood. Next the bark is invaded and cankers develop. The cankers are usually long and narrow, spiraling snake-like around the tree. In the central part of a canker the tightly adhering dead bark is black, stringy, and sooty-like with small light colored areas. These light colored areas are usually circular and 1 to 4 mm in diameter. Fruiting bodies are formed underneath slightly raised areas in the central portion of the dead bark. Cankers may occur on both trunk and branches. Small seedlings can be girdled within a year, saplings in two years. Cankers 7.5 by 50 cm with associated decay extending 4 m can be formed on larger trees within 3 years.

DAMAGE AND CONTROL—This fungus causes stain, decay, cankers, and mortality. Wounded trees of all ages are attacked. Control is effected by prevention of mechanical injury to the trees.

REFERENCES—50, 54, 56, 71, 72, 73.

Cytospora chrysosperma Pers. ex. Fr. CYTOSPORA CANKER

HOST—Aspen, balsam poplar, and cottonwood.

DISTRIBUTION—Host range in Alaska.

PATHOGEN—A weak parasite that normally attacks trees which have been subjected to stress. Small branches and twigs can be killed without canker formation. Trunk cankers may or may not be regular in outline and have a slight target-like appearance. The perimeter of the canker is usually sunken with an orange discoloration. After infection, the inner bark turns dark brown and the sapwood underneath

light brown. The dead bark falls from the tree in large pieces after two or three years. Black fruiting bodies which exude orange to dark red spore masses are produced in the bark several weeks after infection. Later, black flask-shaped fruiting bodies are produced beneath and around the initial fruiting bodies. In this second stage, the spores collect around the fruiting bodies in white masses.

DAMAGE AND CONTROL—Trunk deformation and loss of limbs and twigs with consequent growth reduction and mortality are caused by this fungus. Maintenance of a healthy young stand by short rotations and clear cutting is probably the only control.

REFERENCES—10, 11, 12, 16, 24, 53, 55, 70, 73, 77, 89.

Cenangium singulare (Rehm.) Davidson and Cash — SOOTY BARK CANKER

HOSTS—Aspen, balsam poplar.

DISTRIBUTION—Hosts range in Alaska.

PATHOGEN—This fungus usually invades older stands that have suffered some form of mechancial injury. Once the fungus is established in the stand it builds up rapidly, infecting both wounded and seemingly unwounded trees. After infecting a wound, the fungus moves into the inner bark and cambium. Cankers develop rapidly and within four years can be as much as 4 m long. A canker first appears as a sunken oval area with blackened inner bark. Invasion of bark tissue is too rapid for prominent callus formation. Two to three years later, the outer bark sloughs off and exposes the blackened inner bark which is a uniform sooty black. As the outer bark sloughs off, the cankers become somewhat concentrically zoned and small disk-shaped fruiting bodies are formed on the dead bark. The dead bark easily crumbles in the hand and resembles soot, yet remains attached to the tree trunk for several years.

DAMAGE AND CONTROL—The fungus is a major cause of aspen mortality. Control is accomplished by maintenance of a young vigorous stand and avoiding wounding of the trees.

REFERENCES—1, 28, 68, 70, 73, 80.

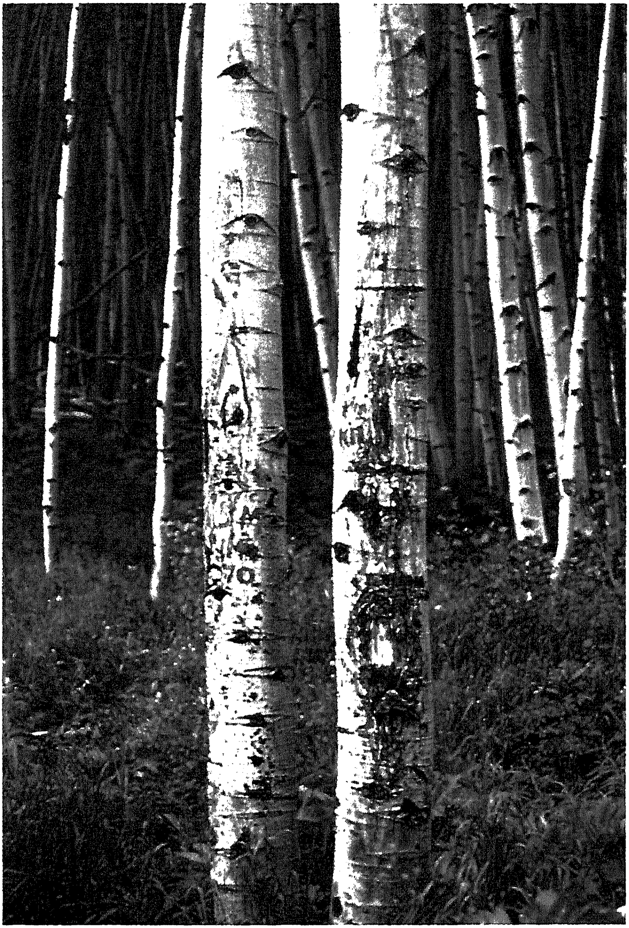

Figure 80—Crytosphaeria canker on 12″ dbh aspen.

Figure 81—Small linticular spots diagnostic of Cryptosphaeria canker.

Figure 82—Cytospora canker on aspen.

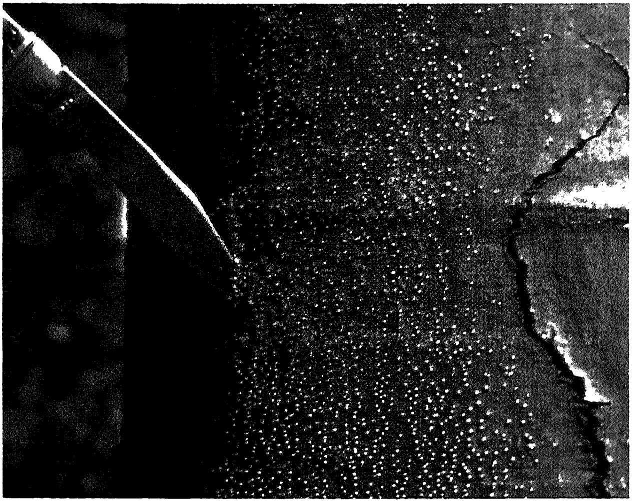

Figure 83—Perfect stage *(Valsa sordida)* of *Cytospora chrysoperma* fruiting.

Figure 84—Sooty bark canker on aspen.

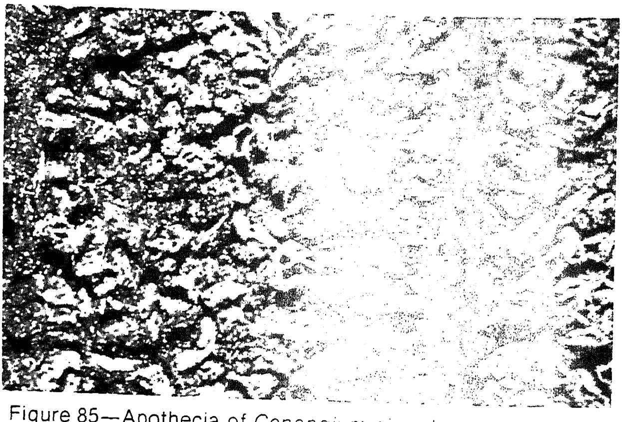

Figure 85—Apothecia of *Cenangium singulare* on dead aspen bark.

HOST—Aspen.

DISTRIBUTION—Host range in Alaska.

PATHOGEN—Causes a black canker of aspen. A circular dead area appears after infection, on the trunk or a branch junction at a fresh wound. A callus fold develops and walls off the infection during cambial growth. During the dormant season, new cambium and bark are invaded and killed by the fungus. Repetition of this cycle for a number of years results in a target-shaped canker formed of successive rings of dead bark. After several years, the dead bark sloughs off exposing concentric rings of dead woody tissue. Later the cankers become oval as their vertical growth is much faster than their horizontal growth. Older cankers can be irregular in shape with massive callus folds and black flaring dead bark. Small black fruiting bodies are formed in the spring along the border on wood that has been dead at least a year. Spores, which are spread principally by sap feeding insects, are exuded in sticky masses.

DAMAGE AND CONTROL—Damage consists mainly of trunk deformity. Mortality due to this fungus is uncommon as tree diameter growth generally exceeds canker enlargement. Prevention of wounding, short rotations, and clear cutting are the only controls.

REFERENCES—1, 63, 69, 70, 73, 88, 123, 124.

Venturia populina Frabic SHEPARDS CROOK DISEASE

HOST—Aspen and balsam poplar.

DISTRIBUTION—South-central Alaska.

PATHOGEN—In spring and early summer, angular black spots are formed on leaves and twigs. Infected leaves curl, turn black and die. The adjoining twigs then become withered, blackened and hooked at the tip. New shoots may be killed as they start to grow. Wet or damp weather favors the pathogen which remains dormant during hot dry summers. Trees with insect injury are more susceptible to infection.

DAMAGE AND CONTROL—Stunting and malformation of seedlings and sprouts. Control is effected on ornamentals by removal of blighted twigs. No practical control exists for forest stands.

REFERENCES—1, 29, 30, 73.

Didymascella thujina (Durand) Maire — CEDAR LEAF BLIGHT

HOST—Western red cedar.

PATHOGEN—The fungus produces small dark brown fruiting structures on the upper side of cedar needles. Usually one to three spherical or oval structures are formed just under the epidermis. At maturity, a flap of epidermis is pushed aside when conditons are moist and the spores are forcibly ejected into the air. After spore discharge, the fruiting structure falls out and leaves a black cavity in a dead brown needle. A cedar severely infected first appears reddish and later grey.

DISTRIBUTION—Host range in southeast Alaska.

DAMAGE AND CONTROL—Seedlings can be killed by the fungus which usually causes only growth loss and a reduction of vigor in older trees. Control is not practical in the forest but may be accomplished by the use of fungicides in nurseries.

REFERENCES—4, 19, 53, 99.

Sirococcus strobilinus Preuss. — SIROCOCCUS SHOOT BLIGHT

HOSTS—Western hemlock, mountain hemlock, and Sitka spruce.

DISTRIBUTION—Southeast Alaska.

PATHOGEN—-A fungus infesting young lateral or terminal shoots. Initial infection occurs on juvenile needles, later moving down into the developing shoots. Small cankers appear and growth is retarded on one side of the shoot causing it to bend into a characteristic hook shape. Death of the

shoot or terminal follows and small black circular fruiting bodies appear. Mature spores are disseminated by the splashing of water drops. Development of the fungus is favored by high atmospheric moisture, mild temperatures, and low light intensities, conditions typical of dense young growth stands in southeast Alaska.

DAMAGE AND CONTROL—Sirococcus causes a wilting and die-back of the shoot tips and occasionally seedling and sapling morality. Mature trees suffer little damage. Growth reduction and stem malformation cause the greatest losses in the younger age classes. Thinning is possibly the best control in younger stands; none is practical in the older stands. Fungicides are available for control in nurseries.

REFERENCES—55, 90, 94, 97, 105, 117, 122.

Endocronartium harknessii (J. P. Moore) Y. Hirat. WESTERN GALL RUST

HOST—Lodgepole pine

DISTRIBUTION—Southeast Alaska.

PATHOGEN—A rust fungus that can infect directly from pine to pine without an alternate host. Like the other rusts, it is an obligate parasite and depends on a living host for its survival. It causes globose, hemispherical, or pyriform galls on the branches and small stems of lodgepole pine. In the spring when the fungus is fruiting the bright orange spores give the galls a distinctive orange coloration. Galls eventually girdle and kill the branch or stem and when this occurs, the rust dies.

DAMAGE AND CONTROL—The fungus causes growth loss, stem deformation and mortality of tops and limbs beyond the galls. Control is possible by removing infected trees or by pruning infected branches.

REFERENCES—2, 5, 18, 19, 93, 99, 125.

Figure 86—Ceratocystis canker on aspen.

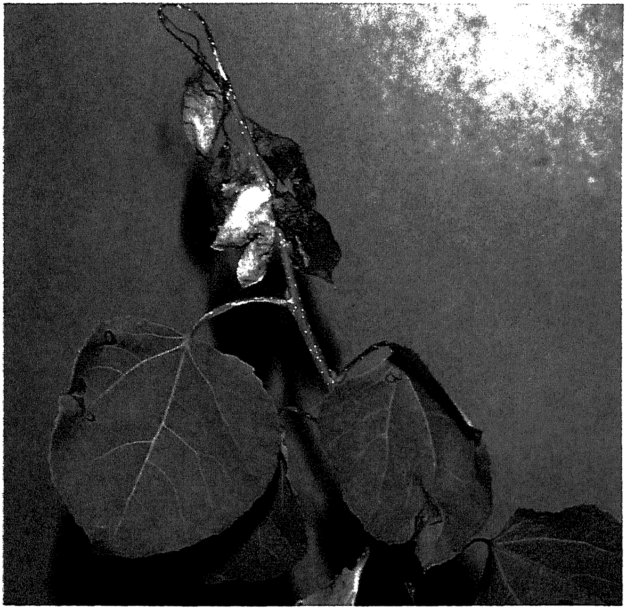

Figure 87—Crook of aspen caused by *Venturia populina.*

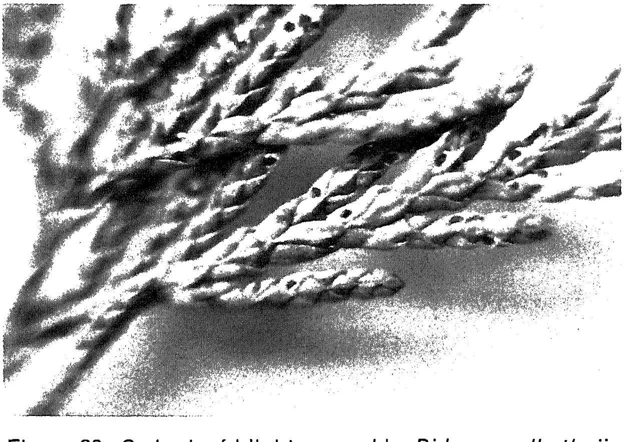

Figure 88–Cedar leaf blight caused by *Didymascella thujina*

Figure 89—Deformed terminals of western hemlock caused by *Sirococcus strobilinus.*

Figure 90—Gall on shore pine caused by *Endocronartium harknesii.*

Chrysomyxa ledicola Lagerh. SPRUCE NEEDLE RUST

HOSTS—White spruce, black spruce, and Sitka spruce.

DISTRIBUTION—Interior and southeast Alaska on spruce where the ranges of spruce and Laborador tea (*Ledum* spp.) coincide.

PATHOGEN—A heterocyclic rust with one stage of its life cycle on spruce and the other on Laborador tea. The rust occurs on spruce only where the alternate hosts (*Ledum* spp.) are found, but can occur solely on Laborador tea outside the range of spruce. Current year spruce needles are infected. The trees have a distinct orange tinge when the rust is fruiting on the needles.

DAMAGE AND CONTROL—Causes a pre-mature defoliation leading to growth loss. Little damage usually occurs unless the tree is infected for several consecutive years. Removal of alternate hosts in the vicinity of spruce or spraying with fungicides in the spring can reduce infestation but this is not economically justified except for high value plantations.

REFERENCES—5, 19, 53, 99, 110, 125.

Chrysomyxa arctostaphyli Diet. SPRUCE BROOM RUST

HOSTS—White spruce, black spruce, Sitka spruce.

DISTRIBUTION—Interior and southeast Alaska where the range of spruce and bearberry (*Arctostaphylos uva-ursi* (L.) Spreng.) coincide.

PATHOGEN—A heterocyclic rust with one stage of its life cycle on spruce and the other on bearberry. It is an obligate parasite perennial and systemic in witches brooms on spruce. Fruiting occurs on current year's needles giving the brooms an orange or yellowish coloration. The needles are shed in the fall and the brooms appear dead until spring. The fungus causes a purple-brown leaf spot on the alternate host, bearberry.

DAMAGE AND CONTROL—Loss of height and diameter growth, bole deformation, and mortality are associated with

the presence of the fungus on spruce. There is no practical control in forest stands. However, removal of the brooms on ornamentals can reduce losses.

REFERENCES—5, 19, 53, 99, 125.

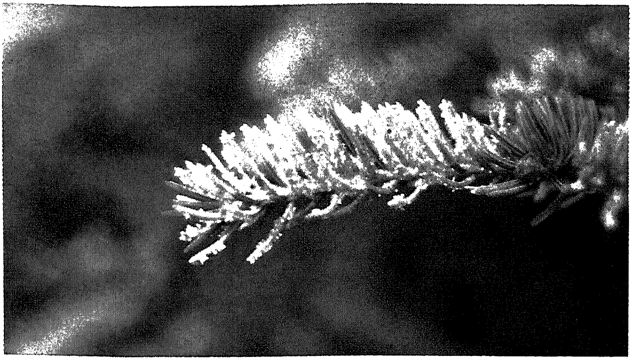

Figure 91—Aecia of *Chrysomyxa ledicola* on white spruce needles.

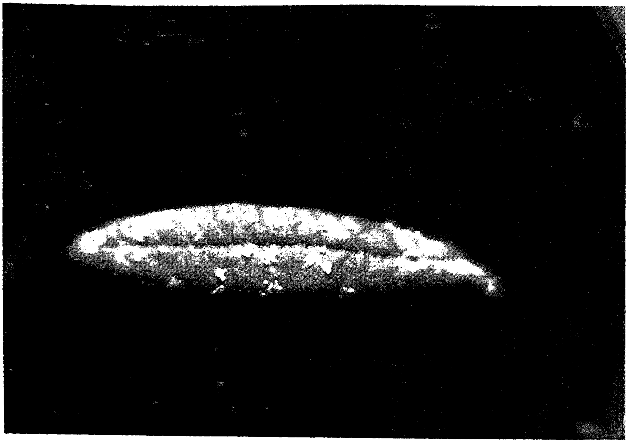

Figure 92—Uredina of *Chrysomyxa ledicola* on Labrador-tea leaf.

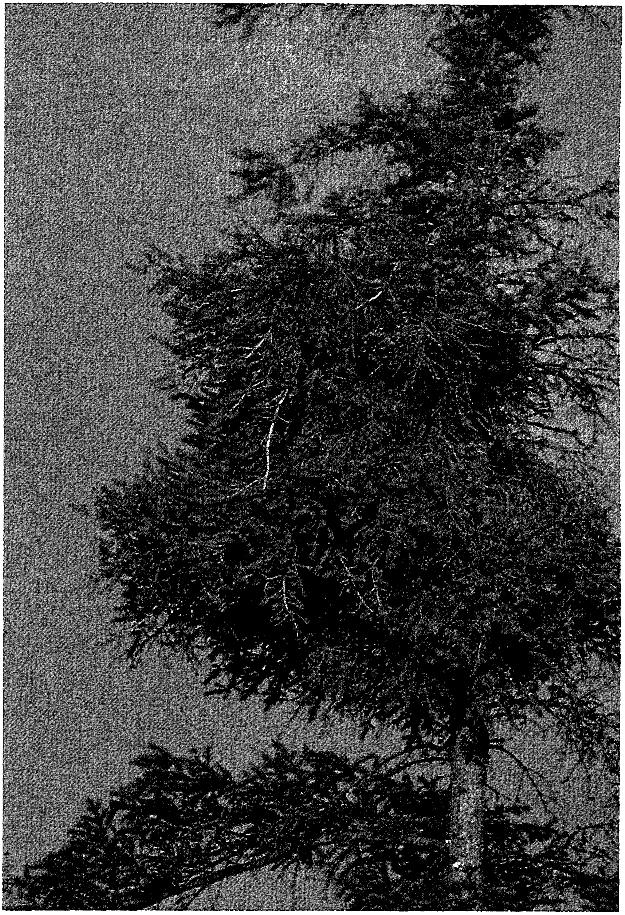

Figure 93—Broom on white spruce caused by *Chrysomyxa arctostaphyli.*

Decay caused by heart and root rotting fungi is probably the greatest single cause of disease related volume loss in Alaska.

The loss is particularly acute in old growth stands in southeast Alaska where 13.2 million cubic feet per year are lost in the Prince of Wales Working Circle alone. Decay not only causes volume loss but also increases logging and milling costs and complicates management by introducing errors in yield and cruise computations. Not all of the decay fungi presented in the key and in this section of the handbook cause extensive damage. Many are listed only because they are widespread and very noticeable.

Identification Key

1. Fruiting body mushroom-like with gills on lower surface __________ 2

1'. Fruiting body not mushroom-like __________ 4

2. Gills pale yellowish, spores, yellow-brown __________ *Pholiota* sp.

2'. Gills white, spores white __________ 3

3. Stem central __________ *Armillariella mellea*

3'. Stem eccentric __________ *Pleurotus* sp.

4. Fruiting body appressed to the substrate __________ 5

4'. Fruiting body shelving or hoof shaped __________ 7

5. Fruiting body dark colored __________ 6

5'. Fruiting body white, yellow, or greyish __________ *Poria rivulosa*

6. Fruiting bodies light to dark brown, cracked with age, context chocolate brown, perennial; on undersides of logs or root crotches ______ *Phellinus weirii*

6'. Fruiting bodies black, cinder-like, sterile, on birch only. ______ *Poria obliqua*

7. Fruiting body with spines or pendant teeth, soft, fleshy, white. ______ *Hericium* sp.

7'. Fruiting body without spines or pendant teeth ______ 8

8. Fruiting body annual ______ 9

8'. Fruiting body perennial, woody ______ 14

9. Upper surface white to light buff, greyish, or banded __10

9'. Upper surface otherwise ______ 13

10. Upper surface banded ______ 11

10'. Upper surface otherwise ______ 12

11. Upper surface with bands of same color, lower surface purplish, on dead conifers ____ *Hirschioporus abietinus*

11'. Upper surface with multi-colored bands on grey background, lower surface white, on dead hardwoods occasionally conifers ______ *Polyporus versicolor*

12. Fruiting body thick, rubbery, upper surface white, hairy, rough, on conifers. ____*Polyporus borealis*

12'. Fruiting body corky, upper surface smooth, white to light brownish or greyish. On birch ______ *Polyporus betulinus*

13. Fruiting body shelf-like if on trunk of tree and cabbage-shaped if on ground at base of tree, upper surface hairy, yellow-green to yellow-brown, dark brown when old. On conifers. ______ *Polyporus schweinitzii*

13'. Fruiting body yellow to bright orange turning grey to white and falling apart when old, on conifers and hardwoods. ______ *Polyporus sulphureus*

14. Context white or light colored ______ 15

14'. Context yellow-brown or dark ______ 17

15. Fruiting body white throughout, chalky, bitter taste, on conifers ______ *Fomitopsis officinalis*

15'. Fruiting body not as above; on conifers and hardwoods ______ 16

16. Fruiting body usually with a red outer margin, upper surface grey to blackish, context light buff, on conifers and hardwoods ______ *Fomitopsis pinicola*

16'. Fruiting body shelving to crust like, upper surface light brown or grey, margin of under surface without pores, context white, anise odor when fresh, on underside of logs and in duff at base of tree, on conifers occasionally hardwoods. ______ *Heterobasidion annosum*

17. Tubes in clearly defined layers ______ 18

17'. Tubes not in clearly defined layers ______ 20

18. Upper surface smooth, ridged, grey, brown, or nearly black, margin rounded with narrow band free of pores, context brown, older tube layers often filled with white mycelium, under surface white turning brown where touched, on conifers and hardwoods. ______ *Ganoderma applanatum*

18'. Upper surface cracked ______ 19

19. Upper surface dark, cracked, lower surface brown or grey, tubes with white flecks, massive, mound-like on hemlock ______ *Fomes robustus*

19'. Upper surface cinder-like, greyish black to black, with radial and tangential cracks, white flecks in brown context, on hardwoods. ______________ *Phellinus tremulae*

20. Upper surface grey, reddish brown or black, pubescent with concentric ridges, context yellow brown to reddish brown, on conifers. ______________ *Phellinus pini*

20'. Upper surface grey to tan, concentrically ridged, smooth, context brown, fruiting body hoof-shaped on hardwoods. ______________ *Fomes fomentarius*

Heterobasidion annosum (Fr.) Bref. FOMES ROOT AND BUTT ROT

HOSTS—Sitka spruce, western hemlock

DISTRIBUTION—Southeast Alaska.

SPOROPHORES—Perennial, irregular in outline, shelving or crust-like, woody or leathery. Upper surface concentrically ringed dark brown to black. Lower surface white or brownish white with small pores and a sterile margin (no pores). Contex white or cream. The conks have an anise-like odor when fresh and are often hidden by litter at the base of the tree.

DECAY—Wood with incipient decay is pinkish to dull violet (color varies with host species) but remains hard and firm. Typically decayed wood has small elongated pockets with or without small black flecks in the white fiber filling the pockets. The white pockets eventually run together leaving a spongy white mass with black flecks. In the final stage only a hollow butt is left.

DAMAGE AND CONTROL—The fungus causes a white spongy rot of live conifers and tends to kill trees in groups. Control in the forest consists of stump treatment with borax, zinc chloride, or innoculation with *Peniophora gigantea* during thinnings and avoiding damage to leave trees.

REFERENCES—7, 8, 9, 16, 17, 19, 20, 26, 27, 30, 37, 38, 39, 46, 47, 49, 51, 53, 74, 79, 92, 95, 96, 99.

Ganoderma applanatum (Pers. ex Wallr.) Pat

ARTISTS CONK

HOSTS—Conifers and hardwoods.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Perennial, woody, shelflike. Upper surface smooth, concentrically ridged, gray to grayish black. Under surface white when fresh turning yellowish with age, small round pores. When fresh the underside turns brown immediately when touched. Context dark reddish brown, layered, tubes in older layers sometimes overgrown with white mycelium.

DECAY—Wood in the incipient stage is characterized by bleached areas encircled by a dark brown band in most host species. In western hemlock, the areas are violet to lilac. In the typical stage, the wood is whitish to cream, mottled, soft and spongy, and usually with fine black zone lines.

DAMAGE AND CONTROL—This fungus causes a white mottled rot and also attacks timber in use. The most effecive controls are removal of infected trees and prevention of wounding of uninfected trees.

REFERENCES—7, 16, 17, 19, 20, 21, 43, 47, 50, 53, 74, 92, 99.

Figure 94—Decay caused by—and conk of—*Heterobasidion annosum* on western hemlock.

Figure 95—Conk of *Ganoderma applanatum* on birch.

Figure 96—Decay of mountain hemlock caused by *Ganoderma applanatum.*

Fomes fomentarius (Fr.) Kichx. TINDER FUNGUS

HOST—Birch.

DISTRIBUTION—Throughout the range of birch in Alaska.

SPOROPHORE—Perennial, woody, hoof-shaped. Upper surface concentrically zoned, smooth, gray or gray-brown to black. Lower surface brown with small regular pores. Contex dark brown, tubes somewhat stratified and partially filled with or incrusted with white mycelium.

DECAY—In the incipient stage, decayed wood is brownish and firm while in the typical stage it is soft, spongy, yellow white, with narrow brown to black zone lines and small radial cracks.

DAMAGE AND CONTROL—This fungus causes white rot of both sapwood and heartwood. Presence of a conk indicates little usable heartwood. Control consists of removal of infected trees and prevention of wounding and shortened rotations.

REFERENCES—7, 19, 45, 53, 99.

Phellinus tremulae (Bond) Bond et Boriss. FALSE TINDER FUNGUS

HOSTS—Birch, aspen and cottonwood.

DISTRIBUTION—Throughout host range in Alaska.

SPOROPHORE—Perennial, hoof-shaped. Upper surface zoned, greyish black to black, becoming cracked and cinder-like with age. Lower surface brown with small circular pores. Context layered and rusty brown with many tubes in older layers filled with white mycelium.

DECAY—Wood in the incipient decay stage is yellowish white or with white spots, streaks, or large areas of heartwood surrounded by a yellowish green to brownish black zone. In the typical decay stage, the wood is lightweight, soft, and whitish with fine black zone lines throughout.

DAMAGE AND CONTROL—This fungus causes a white trunk rot. Presence of a conk indicates considerable decay. Shortened rotations and removal of infected trees during improvement cuttings in the forest helps reduce the incidence of this pathogen. Infected wood must be burned as the fungus will continue to develop in the down material.

REFERENCES—7, 19, 53, 66, 87, 94.

Figure 97—Conk of *Fomes fomentarius* on birch.

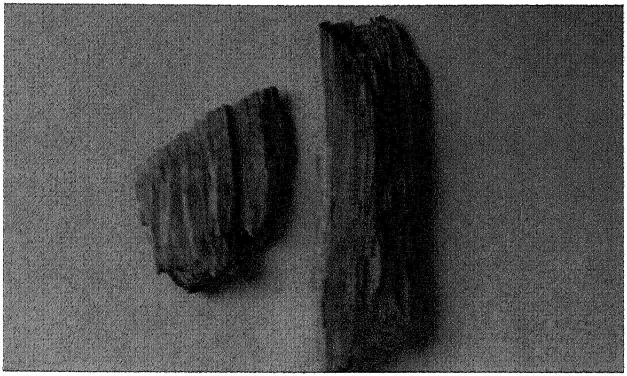

Figure 98—Decay of birch caused by *Fomes fomentarius*.

Figure 99—Conk of *Phellinus tremulae* on birch.

Figure 100—Decay of birch caused by *Phellinus tremulae.*

Fomitopsis officinalis (Vill. ex. Fr.) Bond et. Sing. QUININE CONK
(= Fomes laricis)

HOSTS—Sitka spruce, hemlock.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Variable. Hoof shaped to long and cylindrical. Upper surface zoned, white, and turning grayish or brownish with age. Under surface white with small regular pores. Context white, soft, cheesy, then becoming chalky with age. The conk has a bitter taste.

DECAY—Wood in the incipient stage has a light yellowish, reddish discoloration. In the typical stage the wood is in brown cubes which are easily crumbled and there are thick, bitter tasting mycelial felts in the shrinkage cracks.

DAMAGE AND CONTROL—The fungus causes a brown cubical rot. A single conk on the bole indicates a cull tree. Shortened rotations may act as a control.

REFERENCES—7, 19, 53, 92, 99.

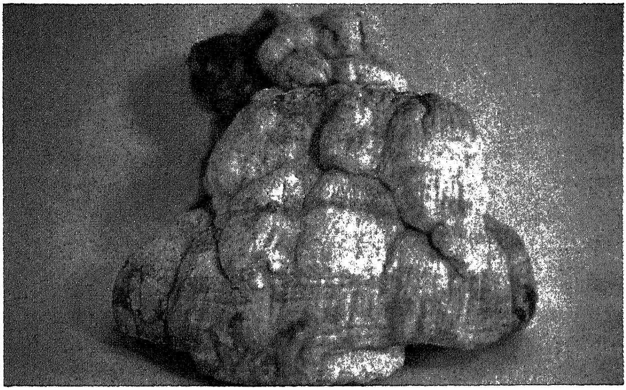

Figure 101–Conk of *Fomitopsis officinalis*.

Fomitopsis pinicola (Swartz ex. Fr.) Karst (= *Fomes pinicola*) — RED BELT FUNGUS

HOSTS—Spruce, hemlock, western red cedar, lodgepole pine, birch.

DISTRIBUTION—Coastal and interior Alaska.

SPOROPHORE—Perennial, hard, woody, flat to hoof-shaped. Upper surface zoned, smooth, gray to black, usually with a reddish band near the margin. Under surface creamy white with minute pores. Contex layered and light buff in color.

DECAY—Wood in the incipient stage is stained a light brown or yellow brown. Wood in the typical stage is reddish or yellow brown, cubical, and crumbly. Conspicuous mycelial felts form in the cracks.

DAMAGE AND CONTROL—This fungus causes a brown cubical heart-rot and sap-rot. Infection occurs through wounds. Timber in service is susceptible to decay. Control is accomplished by effective slash disposal, removal of infected trees, and not wounding healthy trees.

REFERENCES—7, 8, 9, 16, 17, 19, 20, 21, 26, 43, 46, 47, 49, 52, ,53 79, 92, 99, 100.

Phellinus pini (Thore. ex. Fr.) Pilat. (= *Fomes pini*) — RING SCALE FUNGUS

HOSTS—Sitka spruce, white spruce, black spruce, western hemlock, western red cedar, and lodgepole pine.

DISTRIBUTION—Throughout the hosts range in Alaska.

SPOROPHORE—Irregular, usually hoof or shell shaped, hard and woody. Upper surface dark brown, hairy (when young), with concentric ridges and a narrow velvety, light brown to golden margin. Under surface dark brown with pores which are variable in size and shape. Contex stratified, yellow brown when young and dark brown when old. Blind conks or punk knots (swollen knots filled with mycelium) are common.

DECAY—The incipient stage appears as a discoloration of the heartwood. In white spruce, the discoloration is light purplish to gray, later changing to reddish brown. In western red cedar the discoloration is a narrow bluish to reddish brown band along the margins of the more advanced decay. The typical stage consists of elongated spindle shaped pockets or cavities parallel to the grain and sometimes separated by apparently sound wood which may be resin soaked. Decay pockets may be empty or filled with a mass of white fibers. Fine black to brown zone lines may be present.

DAMAGE AND CONTROL—This fungus causes a white pocket rot that can extend the entire length of the bole. Control is not economically feasible in the forest stand.

REFERENCES—7, 9, 17, 19, 43, 47, 48, 52, 53, 79, 91, 92, 99, 100.

Fomes robustus Karst.

HOST—Western and mountain hemlock.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Brown perennial usually located on the underside of limbs or branch stubs, but sometimes occurring directly on the trunk. Upper surface dark brown to black and cracked. Under surface yellow brown to brown with small regular pores. Context yellow brown with streaks of white mycelium.

DECAY—Incipient decay appears as a brown to purple discoloration in irregular patches. Typical decay has a light bleached look and appears laminated on radial sections because of differences in coloration of spring and summer wood. There are light buff to brown horizontal streaks on tangential sections. Brown zone lines are common.

DAMAGE AND CONTROL—This fungus causes a white rot of sapwood and heartwood. Decay is usually confined to side of trunk where infection occurred and normally extends only a few feet above and below the conk. Decay of the sapwood causes a sunken canker. There is no practical control.

REFERENCES—9, 43, 47, 53, 92.

*Hericium abietis** (Wier ex. Hubert) K. Harrison

HOSTS—Western hemlock and Sitka spruce.

DISTRIBUTION—Hosts range in Alaska.

SPOROPHORE—Annual, soft, fleshy, white, coral-like and composed of many hanging spines. The sporophores are found usually in the fall on the sides and ends of down logs or logs in decks and on scars on standing trees.

DECAY—The early stages of decay appear in the heartwood as a yellowish to brown stain which later changes to long spindle-shaped yellow spots. In the latter stages of decay, the wood is riddled with long spindle-shaped pockets which may or may not contain a yellowish mycelium. In this stage, the wood is very splintery and fiberous and has a honeycombed appearance in cross-section.

DAMAGE AND CONTROL—This fungus causes a trunk and butt rot of both standing and down trees. There is no practical control other than prevention of tree wounding.

REFERENCES—7, 19, 28, 43, 49, 51, 53.

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*There are other closely related species on both hardwoods and conifers so the use of more detailed keys are recommended for precise species identification.

Figure 103—Conks of *Fomitopsis pinicola* on Sitka spruce.

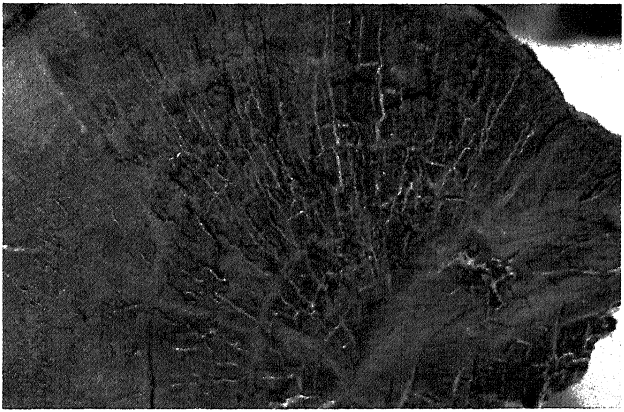

Figure 104—Decay caused by—and mycelium of—*Fomitopsis pinicola* on Sitka spruce.

Figure 105—Conks of *Phellinus pini* on white spruce.

Figure 106—Punk know on white spruce caused by *Phellinus pini.*

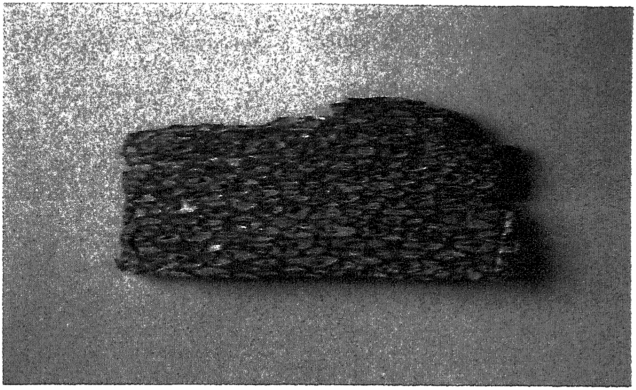

Figure 107—Decay of Sitka spruce caused by *Phellinus pini.*

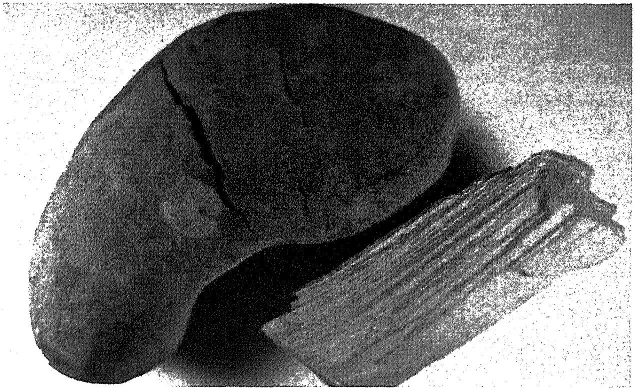

Figure 108—Conk—and decay caused by—*Fomes robustus.*

HOST—Spruce, hemlock, cottonwood, birch, and aspen.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—An annual mushroom occurring in clusters. The upper surface of the cap is scaley, sticky, and yellow brown. The gills on the under surface are yellow at first, later turning brown. Annulus on stem may or may not be present.

DECAY—Incipient decay appears as light yellowish areas in the heartwood. Wood with typical decay is yellow white with yellow or yellow-brown streaks. Strands of yellow brown mycelium, occur along the grain. If the strands of mycelium are pulled from the wood, irregular channels, resembling insect tunnels, remain.

DAMAGE AND CONTROL—This fungus causes a brown mottled rot. Sporophores at the base of or on a living tree indicate extensive decay. Presence of the fungus in large numbers probably indicates an overmature stand. No practical control.

REFERENCES—7, 19, 28, 51, 92.

*There are several species of *Pholiota* found in Alaska. For exact determination of any specific specimen a key for *Pholiota* must be used.

Polyporus borealis Fr.

HOST—Sitka spruce.

DISTRIBUTION—Southeast Alaska.

SPOROPHORE—Annual, shelving, white, fleshy. Upper surface shaggy. Lower surface with large pores. Context white.

DECAY—Decayed wood is a yellowish white and shows white flecks in cross-section. Tangential and radial faces have white patches around small pin holes and cross-grain white streaks. Thoroughly decayed wood fractures in a cubical pattern.

DAMAGE AND CONTROL—This fungus causes a white mottled rot of both living and dead conifers. There is no practical control other than prevention of wounding living trees.

REFERENCES—19, 49, 92.

Figure 111—Fruiting bodies of *Pholiota* sp. on white spruce.

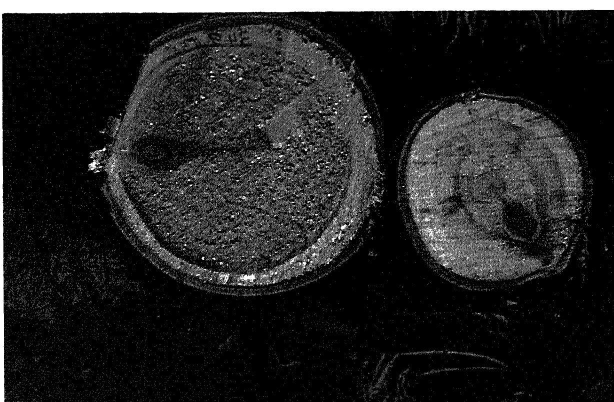

Figure 112—Decay caused by *Pholiota adiposa.*

Figure 113—Conks of *Polyporus borealis* on Sitka spruce.

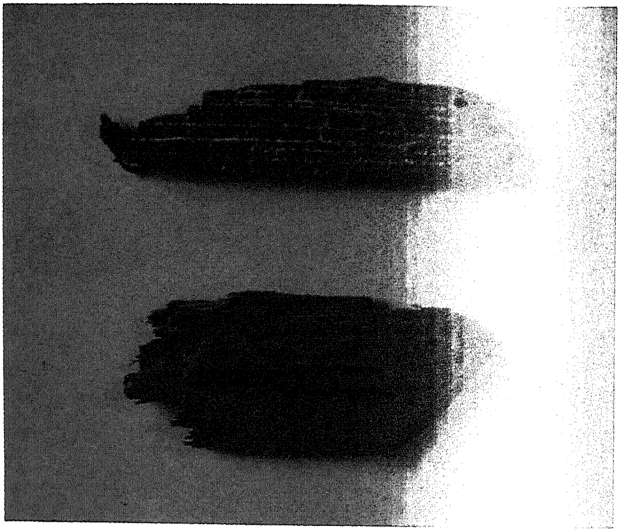

Figure 114—Decay of Sitka spruce caused by *Polyporus borealis.*

Poria obliqua (Pers.) Bres. CINDER CONK

HOST—Birch.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Rough, black, cinder-like sterile conks usually at wounds or knots. Inconspicuous, short-lived fruiting conks may break through the bark after the tree dies.

DECAY—Incipient decay appears as yellowish white streaks and spots in the wood. Wood in advanced decay is white, soft, with fine black zone lines throughout, and a mottled appearance on radial surfaces.

DAMAGE AND CONTROL—The fungus causes a white trunk rot similar to that caused by *Phellinus tremulae.* If conks are present, the entire tree is usually cull. Removal of infected trees and prevention of wounds on healthy trees are the only controls.

REFERENCES—7, 19, 92.

Poria rivulosa (Berke and Curt.) Cooke

HOST—Western red cedar.

DISTRIBUTION—Southeast Alaska, south of Sumner Straits.

SPOROPHORE—Annual, white, thin, crustlike, and poroid. Margins are thin and appear water soaked. Sporophores are rare.

DECAY—The incipient stage is an irregular or crescent-shaped yellowish to brownish discoloration sometimes surrounded by a blue to red zone. In the typical stage, the decayed wood is crumbly, white or yellowish with radial cracks, small pockets, and laminations.

DAMAGE AND CONTROL—This fungus which causes a white rot is responsible for approximately, 45 percent of red cedar decay in southeast Alaska. There is no practical control.

REFERENCES—19, 23, 53.

Phellinus weirii (Murr.) Gilbertson (= *Poria weirii* (Morr.) Murr.) YELLOW RING ROT

HOST—Western red cedar.

DISTRIBUTION—Southeast Alaska, south of Sumner Straits.

SPOROPHORE—Dark brown or yellow brown perennial layers on root crotches and undersides of decayed logs. The layers crack with age. Sporophore margins are buff to white when fresh. Context is layered and brown.

DECAY—The incipient stage occures in yellow to reddish brown stained areas which are crescent shaped or irregular in cross section. In the typical stage, the wood is yellow brown, stringy, with small pockets and separates at the annual rings with brown mycelium forming between the resulting laminations.

DAMAGE AND CONTROL—This fungus causes a yellow ring rot of butt and roots in both living and dead trees. Control consists of planting mixed stands or non-susceptible species.

REFERENCES—7, 19, 22, 23, 43, 53, 92, 100.

Polyporus betulinus Bull. ex, Fr. BIRCH CONK

HOST—Birch.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Annual, shelving with or without a short lateral stalk, light and corky. Upper surface smooth greyish with an incurving margin which projects below the under surface. Lower surface white at first then turning yellowish or tan and with thick-walled pores. Context thick, white, firm with a distinct pore layer which readily peels off in fresh specimens.

DECAY—Initially both sapwood and heartwood decay is light yellowish brown cracking in cubes with thin white

mycelial felts in the cracks. In advanced stages the wood is reduced to a fine crumbly mass.

DAMAGE AND CONTROL—The fungus causes a brown cubical rot of dead, and dead portions of living birch trees. Little damage is caused to sound living trees. Control consists of shortened rotations.

REFERENCES—7, 19, 92.

Polyporus schweinitzii Fr. VELVET TOP FUNGUS

HOSTS—Sitka spruce and western hemlock.

SPOROPHORE—Normally occurs on the trunk near the tree base or rising from the soil near the base of the tree. Bracket-like when occurring on the trunk and circular with a sunken center when arising from the soil. Annual, dark brown, with yellow brown margin, hairy, soft and spongy when fresh, brittle when dry. The undersurface has large irregularly shaped pores and is dirty green turning deep red brown when bruised.

DECAY—Wood with incipient decay is light reddish brown or yellowish brown. Wood with typical decay is red-to yellow-brown, cubical, brittle, and crumbly with a turpentine odor. Thin resinous mycelial felts may occur in the cracks.

DAMAGE AND CONTROL—The fungus causes a brown cubical butt rot of conifers. Control consists of removal of diseased trees and prevention of injury to healthy trees.

REFERENCES—7, 17, 19, 22, 46, 49, 52, 53, 92, 99.

Polyporus sulphureus Bull. ex Fr. SULFUR FUNGUS, CHICKEN OF THE WOODS

HOSTS—Sitka spruce, western and mountain hemlock, and cottonwood.

DISTRIBUTION—Hosts range in coastal Alaska.

SPOROPHORE—Boad, shelving, soft, watery annual occurring in clusters. Upper surface lemon yellow to orange.

Under surface sulfur yellow with small pores. Contex yellow when fresh. The conk turns white or gray with age.

DECAY—Incipient decay appears as a brown to reddish brown discoloration. Wood with typical decay is dark reddish brown, cubical, brittle, and crumbly. In longitudinal section, the wood sometimes has a rippled look. Thick mycelial felts usually occur in the cracks. This decay closely resembles the decay caused by *Fomitopsis laricis* but the mycelial felts are not bitter to the taste.

DAMAGE AND CONTROL—The fungus causes a brown cubical heart rot. Control is generally not practical.

REFERENCES—7, 9, 19, 43, 47, 49, 52, 53, 79, 92, 99.

Polyporus versicolor L. ex. Fr.

HOSTS—Birch and cottonwood.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Annual, small thin, tough, and leathery. Upper surface hairy and banded with the bands varying from white or greyish to brownish, blackish, or purple. Lower surface and context are white. Pores small.

DECAY—Incipient decay is unnoticeable. Wood with advanced decay is uniformly white, soft, brittle, and much reduced in weight.

DAMAGE AND CONTROL—The fungus causes a white spongy rot of the dead sapwood of hardwood slash, stored logs, and wood in service. There is no need for control in the forest. Clean, dry and well aeriated conditions or treatment with a preservative will control the fungus on wood in service.

REFERENCES—7, 19, 51, 53, 92.

Figure 121—Conks of *Polyporus betulinus* on birch.

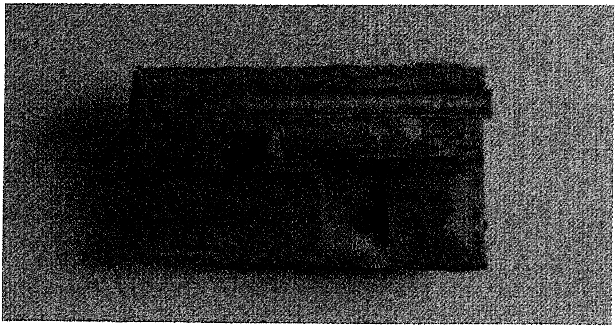

Figure 122—Decay of birch caused by *Polyporus betulinus.*

Figure 123-- Fruiting body of *Polyporus schweinitzii* at the base of a Sitka spruce.

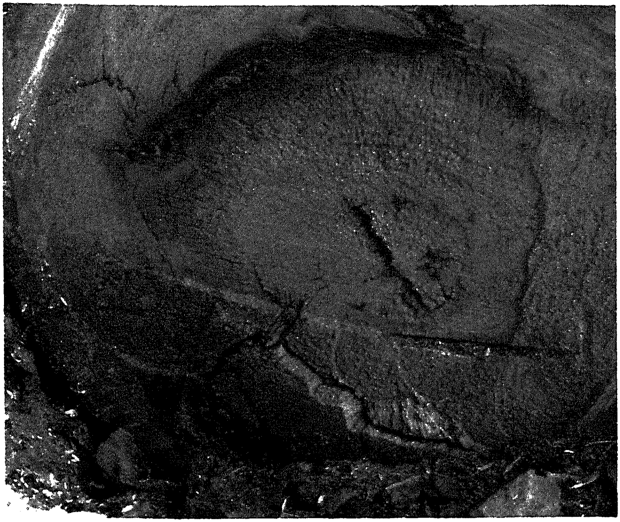

Figure 124—Decay of Sitka spruce caused by *Polyporus schweinitzii.*

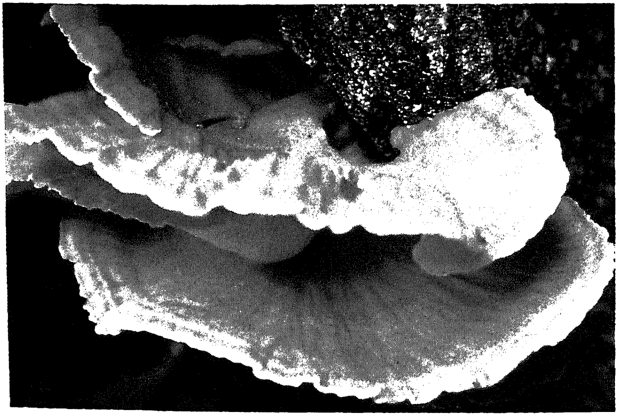

Figure 125—Conk of *Polyporus sulphureus* on eastern hemlock.

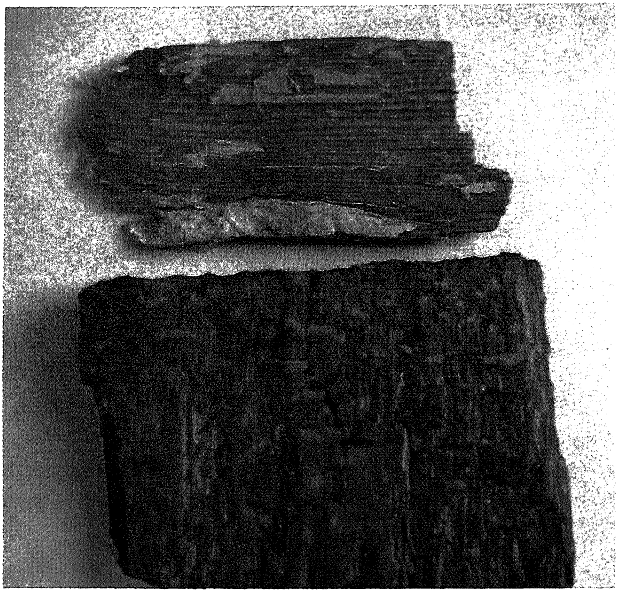

Figure 116—Decay of western hemlock caused by *Polyporus sulphureus.*

Figure 127—Conk of—and decay caused by—*Polyporus versicolor* on birch.

Pleurotus ostreatus Jacq.* THE OYSTER MUSHROOM

HOSTS—Aspen, cottonwood, and birch.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—A fleshy annual mushroom occurring in clusters. Upper surface smooth, white, or greyish. Under surface with prominent gills which extend onto the eccentric stalk.

DECAY—The incipient decay is characterized by a narrow brown band around more advanced decay. Wood in the typical decay stage is white and flaky, with black flecks scattered throughout. Both sapwood and heartwood are decayed.

DAMAGE AND CONTROL—The fungus causes a white flaky rot of hardwoods. Sporophores on logs indicate little usable wood. Control is not practical.

REFERENCES—19, 28, 51, 92.

*For specific determinations a key for the genus should be used.

Hirschioporus abietinus (Dicks. ex. Fr.) Donk (= *Polyporus abietinus* Dicks. ex. Fr.) PURPLE CONK

HOSTS—Sitka spruce, white spruce, western hemlock.

DISTRIBUTION—Host range in Alaska.

SPOROPHORE—Annual, small, thin, shelving, sometimes crustlike. The upper surface is hairy, zoned, and greyish. The under surface is purplish when young turning brown with age. The mouths of the tubes vary from regular to irregular in shape and are conspicuous.

DECAY—Decayed wood in the incipient stage has a faint yellowish to tan color. The wood becomes honey-combed with small pockets in the advanced stage. The pockets are filled with whitish fibers initially but become empty later on and the wood becomes spongy or corky.

DAMAGE AND CONTROL—The fungus causes a white pocket rot of dead coniferous sapwood. Both slash and wood in storage are attacked. No control is necessary in the forest. Clean, dry, and well ventilated conditions will reduce incidence of the fungus on wood in storage.

REFERENCES—7, 8, 16, 17, 19, 20, 21, 26, 43, 46, 47, 48, 51.

Armillariella mellea (Vahl. ex Fri) Karst. SHOE STRING FUNGUS

HOSTS—All tree species in Alaska.

DISTRIBUTION—Hosts range in Alaska.

SPOROPHORE—A honey-colored mushroom occurring in clumps at the base of infected trees and stumps. Dark brown scales on top and white gills underneath. Gills are attached to both stalk and cap, and an annulus may be around the stalk a short way below the gills. Considerable morphological variation exists.

DECAY—In the incipient stage of decay the wood appears faintly water soaked then changes to a light brownish color. In the advanced stage of decay the wood is light yellow or white, soft and spongy, stringy in conifers, with many fine black zone lines. Associated with the decay there may be fan shaped mycelial felts between the bark and wood or black shoe-string like rhizomorphs between the bark and wood and on the surface of the roots or in the soil. In conifers there may be an abnormal resin flow from the root collar.

DAMAGE AND CONTROL—The fungus causes a root-heart and saprot of living and dead trees and can kill trees directly. Trees under stress are attacked and those planted outside their natural range are more susceptible to attack. Best control is to maintain tree vigor.

REFERENCES—3, 7, 19, 23, 28, 43, 46, 47, 51, 53, 79, 85, 92, 99, 107.

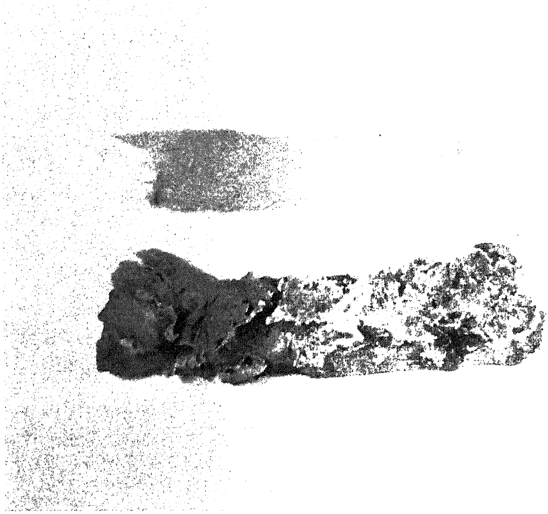

Figure 130—Conk of—and decay caused by—*Hirschioporus abietinus* on western hemlock.

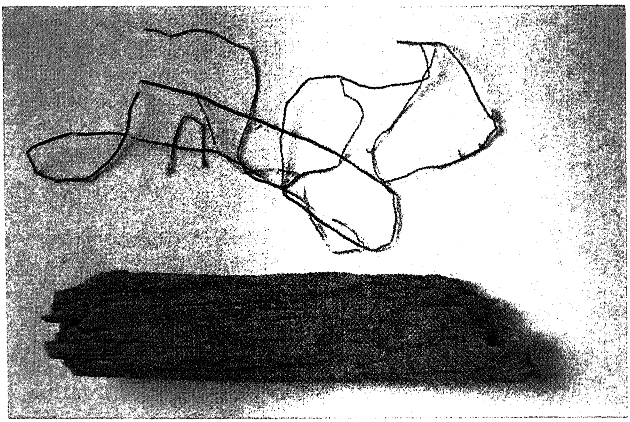

Figure 132—Rhizomorphs of—and decay of western hemlock caused by—*Armillariella mellea.*

Noninfectious or Abiotic Diseases

Diseases which are not caused by parasites and which are noninfectious are referred to as abiotic diseases. These diseases may be caused by many different nonparasitic factors in the environment such as weather, air pollution, animals, deficiencies or excesses of soil minerals, and misuse of chemicals. In many instances the symptoms of some abiotic diseases may closely resemble those of some parasitic diseases making it difficult to determine the cause. Many of the noninfectious injuries serve as an entryway for parasites which will do more damage than the initial injury.

Air Pollution

SULFUR DIOXIDE

SUSCEPTS—All tree species in Alaska.

DISTRIBUTION—Wherever excessive emisions of sulfur oxide (mainly SO-2) occur in the vicinity of large plants using high sulfur oil and coal or using sulfur in their manufacturing processes.

INJURY—Chlorosis, loss of foliage, loss of growth, and death of suscept.

SYMPTOMS—Chronic injury, which results from continued low level emissions of sulfur dioxide, is expressed as a general yellowing of the suscept and a growth loss. On conifers the internodes and terminals are shorter and the needles are smaller with a shorter life and retention. On broad leaved trees the leaves are discolored in irregular flecks and patches before becoming entirely yellowish. Acute injury occurs when a tree is exposed to high concentrations of sulfur dioxide. Needles on conifers with acute injury first appear water-colored then turn tan or reddish-brown as the tissue dies. Either the entire needle or just the distal portion may be affected. On broad leaved trees the leaf margins are affected first then the tissue between the veins. In many instances all of the leaf tissue with the exception of the veins may be killed.

CONTROL—Removal of sulfur oxides from the source emissions.

REFERENCES—7, 25, 32, 53, 59, 60, 61, 64, 77, 78, 83, 87, 98, 108, 109, 111, 112, 113, 114, 115, 116.

Red Belt (Winter Drying)

SUSCEPTS—All tree species in Alaska but mainly the conifers.

DISTRIBUTION—Host range in Alaska.

INJURY—Foliage and buds killed. Sudden warm spells or warm winds that occur during the winter may cause a sudden increase in transpiration. If the soil is frozen when this occurs, water is not available to replace that which is transpired. Under these circumstances the tree reacts as it would in a period of drought and injury is expressed by browning and dying of the foliage when warm weather comes in the spring. Foliage within unopened buds at the time of the warm winds are usually unaffected and foliage on the sides of trees facing the winds will display the greatest damage. If the warm wind occurs high along the side of the valley the damage is displayed as a sharply defined reddish belt along the side of the valley. Affected trees usually not permanently damaged.

CONTROL—None applicable.

REFERENCES—7, 19, 52.

Frost Injury

SUSCEPTS—All tree species in Alaska.

INJURY—Death of foliage, buds and twigs leading to a growth loss and a general weakening of the tree. It may occur as the result of either an early or late frost. Early frost injury takes place in the fall of the year when a frost occurs ahead of its normal occurrance and before the trees are hardened off. Late frost occurs in the spring, the result of an unusually late occurring frost after bud burst. The injury is a result of intercellular and/or intracellular formation of ice crystals which cause cellular deformation and death.

CONTROL—Not applicable for forests. Avoid planting in frost pockets in nurseries and plantations.

REFERENCES—7, 19, 34, 41, 44, 53, 76.

Drought

SUSCEPTS—All tree species in Alaska.

DISTRIBUTION—Wherever soil moisture drops below the level required by trees.

INJURY—Chronic injury results from long-term exposure to low water supplies and is expressed by growth loss and increased susceptibiltiy to parasitic fungi and insects. Chronic injury can be difficult to diagnose. Acute injury occurs when an extreme water deficiency occurs and is expressed by significant growth loss or death.

SYMPTOMS—Wilting, discoloration of foliage, premature leaf fall, death of tree from top of crown down and outside of crown in. The roots are usually the last portion to die.

CONTROL—Practical only with ornamentals or when planting. Avoid planting in wide openings and use protective cover, natural (trees and shrubs already established) or artificial (slash) to reduce soil surface temperatures and for protection from drying winds.

REFERENCES—7, 19, 35, 40, 53.

Animal Damage

SUSCEPTS—All tree species in Alaska.

DISTRIBUTION—Throughout tree range in Alaska.

INJURY—Severed stems, stripped bark, scratched bark, holes in the bark, clipped buds, clipped twigs, clipped cones, seed and seedling destruction. Most injury occurs as a result of the feeding habits of animals, an exception being bear scratching. Sapsuckers (birds), voles, shrews, rabbits, squirrels, porcupines, deer, moose, and bear cause most of the injury in Alaska.

DAMAGE AND CONTROL—Usually the animal's feeding activity causes little loss. If the feeding results in destruction or mutiliation of high value ornamentals and plantations or prevention of regeneration by seed and seedling destruction it then becomes a problem. Control is not practicable in Alaska at this time.

REFERENCES—7, 10, 11, 12, 65, 84.

(See references for detailed keys to determine the animal causing injury.)

Figure 133—Shortening and deformation of western hemlock needles caused by sulfur oxides.

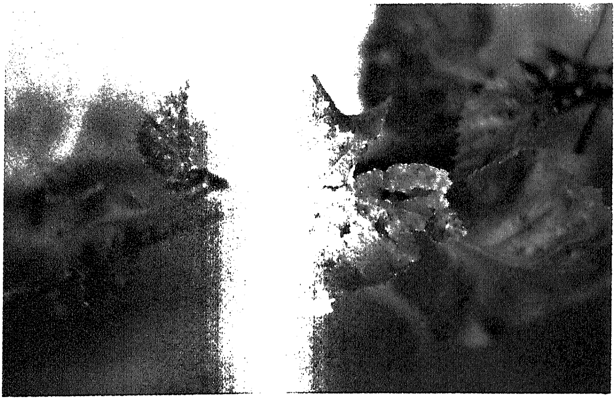

Figure 135—Late frost injury to birch.

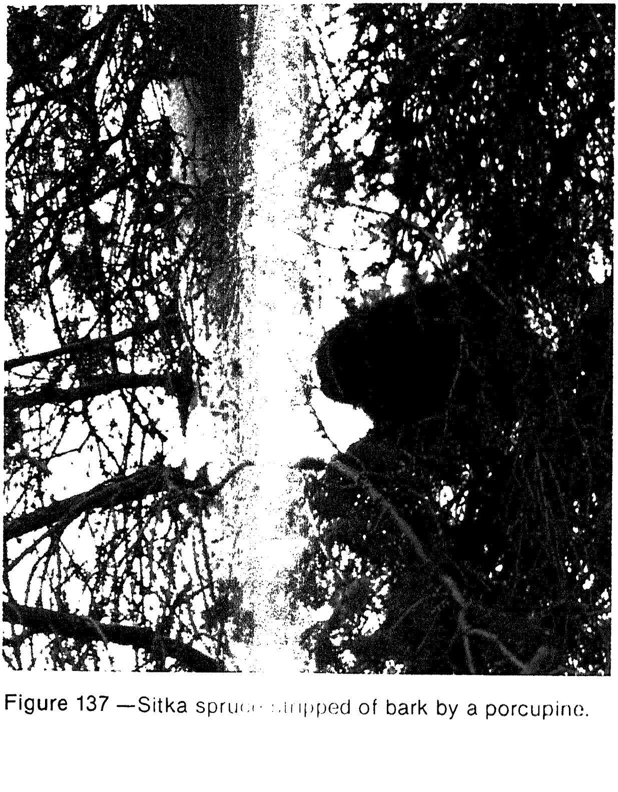

Figure 137 —Sitka spruce stripped of bark by a porcupine.

Disease Glossary

Blind conk—An overgrown knot filled with old conk material or the beginning of a new conk.
Conk—Sporophore, fruiting structure, fructification.
Contex—Interior of a conk or sporophore.
Cortex—Rind or outer layer.
Dioecious—Male flowers on one plant and female flowers on another.
Disease—Impairment, in whole or in part, of the health of trees by living organisms (other than insects) or by chemical or physical factors in the environment.
Endophytic—One organism living within another.
Epiphytotic—A disease causing organism suddenly and destructively affecting plants in a locality.
Heterocyclic rust—A rust fungus requiring two different hosts to complete its life cycle.
Mycelium—The vegetative structure of a fungus.
Obligate parasite—An organism capable of living only as a parasite.
Pathogen—A parasite or virus capable of causing disease.
Perennial—Having a life cycle of more than two years.
Spore—A small reproductive body.
Sporophore—A fungal structure which produces spores; a conk, a fructification.
Stomata—Breathing pore in the epidermis of a plant.
Systemic—Living from year to year within the host plant.
Xylem—The principle water-conducting tissue in the vascular system of a plant.
Zoneline—Black to brown thread or string-line lines formed in decayed wood.

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Index to Disease by Host Plants

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Submitting Insects and Diseases for Identification

People interested in obtaining positive identification of insect and disease specimens should submit samples to specialists. The following procedures for the collection and shipment of specimens should be followed.

Specimen Collection:

- Adequate material should be collected. Collect both healthy and injured material

- Adequate Information: The value of an insect or disease specimen depends on the information regarding its collection.

- Where the specimen was collected; nearest Post Office or town, elevation, aspect.

- When the specimen was collected.

- Who collected the specimen.

- Host description (age, species, general appearance).

- General condition of the surrounding area (fire, blowdown, logging, and so forth).

- Personal opinion of the problem: the collector's opinion can be very helpful.

Shipment of Specimens:

- General: Pack specimens in such a manner that breakage will be minimal.

- Insects: Specimens sent through the mail should be packed to withstand rough treatment.

• Larvae and other soft-bodied insects should be shipped in small screw-top vials or bottles containing at least 70 percent isopropyl (rubbing) alcohol. Make certain that the bottles are sealed well. Include in each vial adequate information, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written on with pencil or India ink. Do not use ball-point pen.

• Pupae and hard-bodied insects can be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the shipping boxes. Pack carefully and make certain that there is very little movement of material within the box. Do not pack insects in cotton.

• Adult moths, butterflies and fragile insects should be folded between paper before packing in the tissue paper.

• Needle Diseases: Do not ship in plastic bags. Sprinkle lightly with water before wrapping in newspaper.

Shipping

• Ship as quick as possible. If samples can't be shipped as soon as possible, store them in a refrigerator.

• Include address inside shipping carton.

• Mark "FRAGILE: INSECT-DISEASE SPECIMENS ENCLOSED—FOR SCIENTIFIC PURPOSES ONLY—NO COMMERCIAL VALUE."

• Specimens from Alaska should be sent to—**Forest Insect and Disease Management**, State and Private Forestry USDA Forest Service, 2221 E. Northern Lights Blvd., Suite 107, Anchorage, AK 99504.

or

Forest Insect and Disease Management, State and Private Forestry, USDA Forest Service, P.O. Box 1628, Juneau, AK. 99802

or

Institute of Northern Forestry, USDA Forest Service Fairbanks, AK. 99701

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Figure 46: Scratchboard adapted from: Grant, T., and C. B. Cottrell. 1964. **Spruce Beetle in British Columbia.** For. Pest Leafl. No. 13, For. Res. Ctr., Can. For. Serv., Victoria, B.D., 7 p.

Figure 65: Scratchboard adapted from: Deyrup, M. A. 1977. **The Insect Community of Dead and Dying Douglas-Fir: Diptera, Coleoptera, and Neuroptera.** PhD Dissert., Coll. For. Res., Univ. Washington, Seattle. 561 p.

Figures 68, 69: Scratchboards adapted from: ________ 1968. **Marine borers, fungi, and fouling organisms of wood.** Janes and Eltringham (ed.). Proceedings of the OECD Workshop. 365 p.

Figure 73: Scratchboard adapted from: Ruppel, D. H. 1974. **Carpenter Ants.** For. Pest Leafl. No. 58, For. Res. Ctr., Can. For. Serv., Victoria, B.C. 7 p.

Figure 74: Scratchboard adapted from: Borror, D. J., and D.M. DeLong. 1964. **An Introduction to the Study of Insects.** Holt, Reinhart, Winston, N.Y. 819 p.

Figure 75: Forest Service photograph no. P2421-PNW.

Figure 77: Scratchboard adapted from: Anderson, R. F. 1966. **Forest and Shade Tree Entomology.** J. Wiley and Sons, Inc., N.Y. 428 p.

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